National Nuclear Security Administration

General Technical Base

Qualification Standard

Reference Guide

MAY 2008

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Acronyms	
A	ampere
AC	administrative control
ACGIH	American Conference of Industrial Hygienists
ALARA	as low as reasonably achievable
ANSI	American National Standards Institutes
ANS	American Nuclear Society
CAA	Clean Air Act
CBDPP	Chronic Beryllium Disease Prevention Program
CDC	Center for Disease Control
CEDE	Committed effective dose equivalent
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
CMPC	classified matter protection and control
CRAD	criteria review and approach documents
CRD	contractor requirements documents
CSE	cognizant system engineer
CSO	cognizant Secretarial Officer
CTA	central technical authority
CWA	Clean Water Act
DBT	design basis threat
DEAR	Department of Energy Acquisition Regulation
DHS	Department of Homeland Security
DNA	deoxyribonucleic acid
DNFSB	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
DP	Office of Defense Programs
dpm	disintegrations per minute
DSA	documented safety analysis
EA	environmental assessments
ED	emergency director
EH	Office of Environment, Safety, and Health
EIS	environmental impact statement
EM	Office of Environmental Management
EMS	environmental management system
EMT	emergency management team
EPHA	Emergency Planning Hazards Assessment
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-To-Know Act
ERO	emergency response organization
ES&H	environment, safety, and health
FAQS	functional area qualification standard
FFCA	Federal Facility Compliance Act
FHA	fire hazards analysis

FRAM	Responsibilities and Authorities Manual
FSAR	Final Safety Analysis Report
GOCO	government-owned, contractor-operated
Gy	gray
HAZMAT	hazardous material
HEPA	high efficiency particulate
HLW	high level waste
IDLH	immediately dangerous to life or health
IH	industrial hygiene
ISM	Integrated Safety Management
ISMS	integrated safety management system
ISO	International Organization for Standardization
kA	kiloampere
LCO	limiting conditions for operation
LCS	limiting control settings
LDR	land disposal restrictions
LLW	low level waste
LLMW	low level mixed waste
m	meter
mA	milliampere
mg	milligram
MC&A	material control and accountability
MeV	million electron volts
MSDS	material safety data sheet
MSHA	Mine Safety and Health Administration
NEPA	National Environmental Policy Act
NESR	Nuclear Explosive Safety Rule
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NMMSS	Nuclear Materials Management Safeguards System
NMR	Nuclear Materials Representative
NIOSH	National Institute for Occupational Safety and Health
NNSA	National Nuclear Security Administration
NPDES	National Pollutant Discharge Elimination System
NPH	natural phenomena hazard
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
ORPS	Occurrence Reporting and Processing System
OSHA	Occupational Safety and Health Administration
Pu	plutonium
PEL	permissible exposure limit
PISA	potential inadequate safety analysis
PNOV	preliminary notice of violation
PPA	Pollution Prevention Act
PPE	personal protective equipment
ppm	parts per million

PSO	program Secretarial Officer
Q	Quality
QA	Quality Assurance
QAP	quality assurance program
QMP	Quality Management Program
QS	quality system
rad	radiation absorbed dose
RCRA	Resource Conservation and Recovery Act
rem	roentgen equivalent man
RIS	reporting identification symbol
RFP	request for proposal
SDWA	Safe Drinking Water Act
SAR	safety analysis report
SARA	Superfund Amendment and Reauthorization Act
SER	Safety Evaluation Report
SI	international standard unit
SL	safety limit
S/RIDs	standards/requirements identification documents
SNM	special nuclear materials
SQA	software quality assurance
SR	surveillance requirement
SSC	systems, structures and components
STEL	short term exposure limit
Sv	sievert
SWDA	Solid Waste Disposal Act
STP	site treatment plan
TLD	thermoluminescent dosimeters
TLV	threshold limit value
TRU	transuranic
TSCA	Toxic Substances Control Act
TSR	technical safety requirement
TWA	time-weighted average
U	uranium
UFP-QS	Uniform Federal Policy for Implementing Environmental Quality Systems
USQ	unreviewed safety question
V	volt
WIPP	Waste Isolation Pilot Plant
WSS	work smart standards

PURPOSE

The purpose of this reference guide is to provide a document that contains the information required for a National Nuclear Security Administration (NNSA) technical employee to successfully complete the General Technical Base Qualification Standard. In some cases, information essential to meeting the qualification requirements is provided. Some competency statements require extensive knowledge or skill development. Reproducing all the required information for those statements in this document is not practical. In those instances, references are included to guide the candidate to additional resources.

SCOPE

This reference guide has been developed to address the competency statements in the November 2007 version of DOE-STD-1146-2007, General Technical Base Qualification Standard. Competency statements and supporting knowledge and/or skill statements from the qualification standard are shown in contrasting bold type, while the corresponding information associated with each statement is provided below it. The qualification standard for the General Technical Base contains 28 competency statements.

The competencies and supporting knowledge, skill, and ability statements are taken directly from the qualification standard. Most corrections to spelling, punctuation, and grammar have been made without remark, and all document-related titles, which variously appear in roman or italic type or set within quotation marks, have been changed to plain text, also mostly without remark. Capitalized terms are found as such in the qualification standard and remain so in this reference guide. When they are needed for clarification, explanations are enclosed in brackets.

Every effort has been made to provide the most current information and references available as of May 2008. However, the candidate is advised to verify the applicability of the information provided. It should be noted that some of the Directives referred to have been archived.

A comprehensive list of acronyms and abbreviations is found at the beginning of this document. It is recommended that the candidate review the list prior to proceeding with the competencies, as the acronyms and abbreviations may not be further defined within the text unless special emphasis is required.

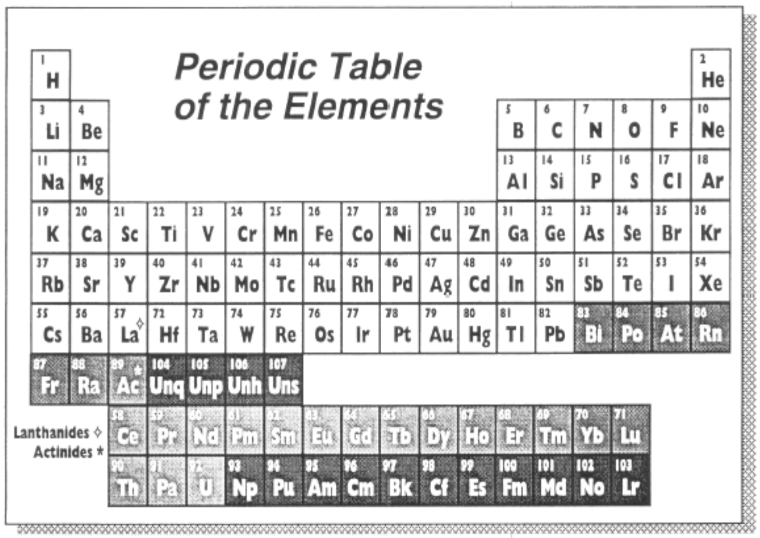
Please direct your questions or comments related to this document to the NNSA Learning and Career Development Department.

TECHNICAL COMPETENCIES

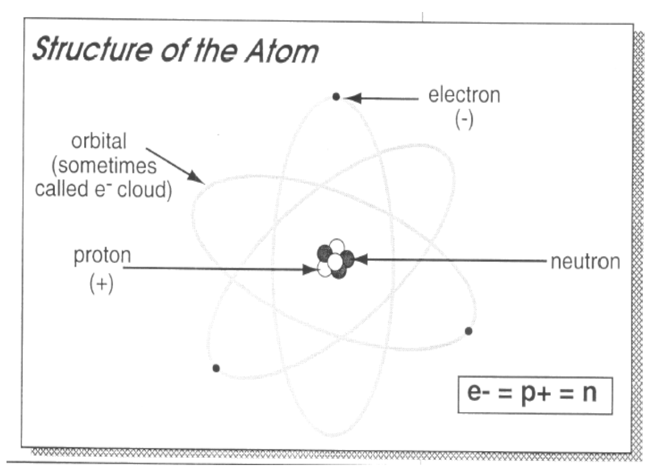
1. Personnel shall demonstrate a familiarity level knowledge of basic nuclear theory and principles.

Background: Basic Nuclear Theory and Principles

Atoms are the building blocks of all matter. The periodic table identifies atoms by their chemical symbol. The atoms in the table are arranged such that atoms with similar chemical properties are grouped in columns.



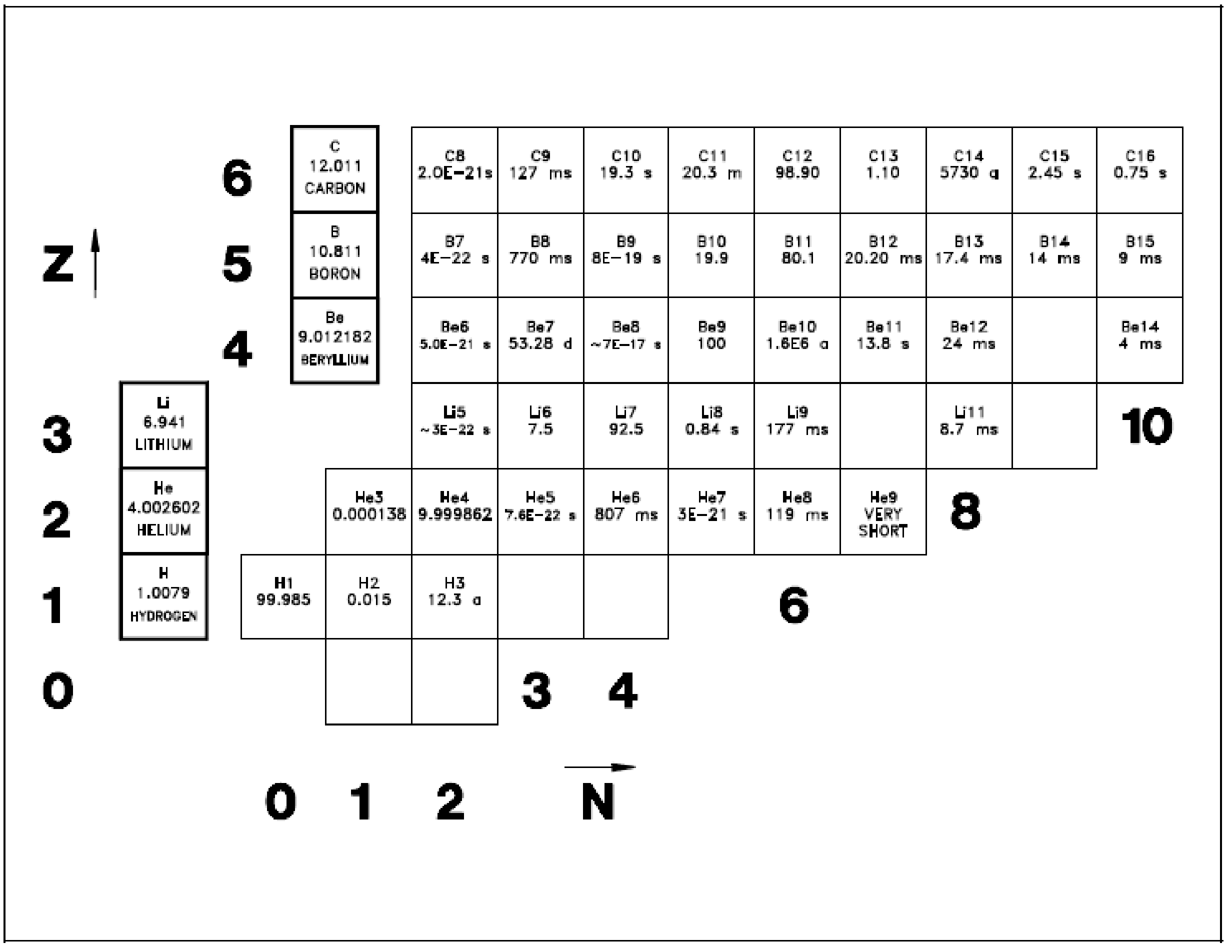
Each atom is made up of elementary particles. The most familiar are the proton, neutron, and electron. The proton and neutron are located within the nucleus, while the electrons “orbit” the nucleus.

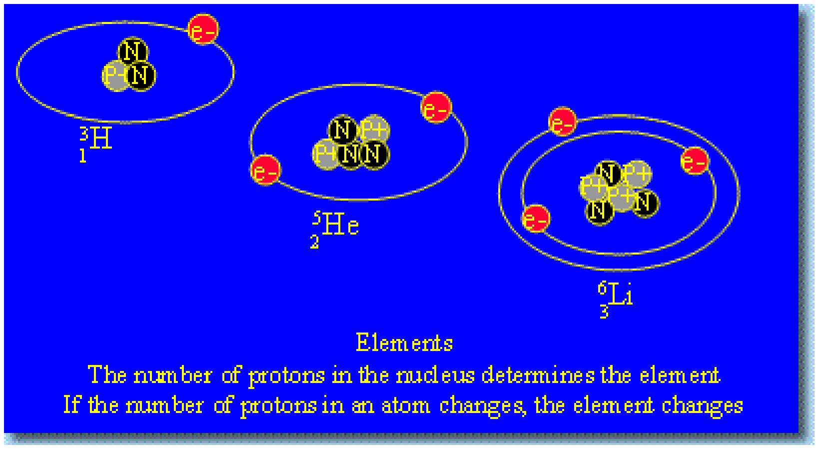


The electron has a negative charge, the proton a positive charge, and the neutron no charge. An atom typically has the same number of electrons as protons and, therefore, has a neutral (0) electric charge (and, therefore, is a neutral atom). Atom can gain or loss electrons in chemical reactions or by impact with energetic particles resulted in an unbalanced electric charge (different number of protons and electrons). These atoms are called ions.

Each type of atom that contains a unique combination of protons and neutrons is called a nuclide. Not all combinations of numbers of protons and neutrons are possible, however approximately 2500 specific nuclides with unique combinations of neutrons and protons have been identified.

For example, a given atom, such as carbon, can contain different numbers of neutrons (Carbon 12 which contains 6 neutrons or Carbon 14 which contains 8 neutrons). The atoms with the same number of protons but numbers of different neutrons are called isotopes. Each atom has several different isotopes. It refers to an atom with a specific number of protons and neutrons. The chart of nuclides below provides a logical arrangement of the isotopes. Isotopes of an element are in the same rows.





There are several different methods utilized to identify atomic nuclides. The following are examples:

$_2He^4$ or ^4_2He The "2" indicates the number of protons, the "4" indicates the total number of protons and neutrons.

He-4 or 4He, Since a given atom has a unique number of protons (e.g., the He atom has 2 protons, U has 92 protons), it is not necessary to identify this in the nuclide symbol.

a. Describe the three forces that are found within a nucleus.

Gravitational forces, electrostatic forces, and nuclear forces act in the nucleus of an atom.

Gravitational Forces

Gravitational forces exist between all bodies with mass. Gravitational forces tend to attract all nucleons (a nucleon is a proton or neutron) toward each other within a nucleus; however, the magnitude of this attractive force is extremely small compared to the electrostatic and nuclear forces in the nucleus.

Electrostatic Forces

Electrostatic forces exist between charged particles (protons +1) within a nucleus. Protons develop a strong repulsive force between other protons in the same nucleus due to their like charge. If only the electrostatic (repulsive) and the gravitational (attractive) forces in a nucleus are considered, the protons in a nucleus should repel one another and cause the nucleus to break apart.

Nuclear Force

A strong attractive nuclear force exists between all nucleons regardless of charge. This is the binding energy that holds the nucleons in a nucleus so that despite repulsive electrostatic forces between protons the nucleus stays together. The nuclear force makes a stable nucleus possible. The nuclear force only acts in a very short range (e.g., within the nucleus) but is very strong as compared with the electrostatic forces within the nucleus (and the electrostatic forces are much stronger than the gravitational forces).

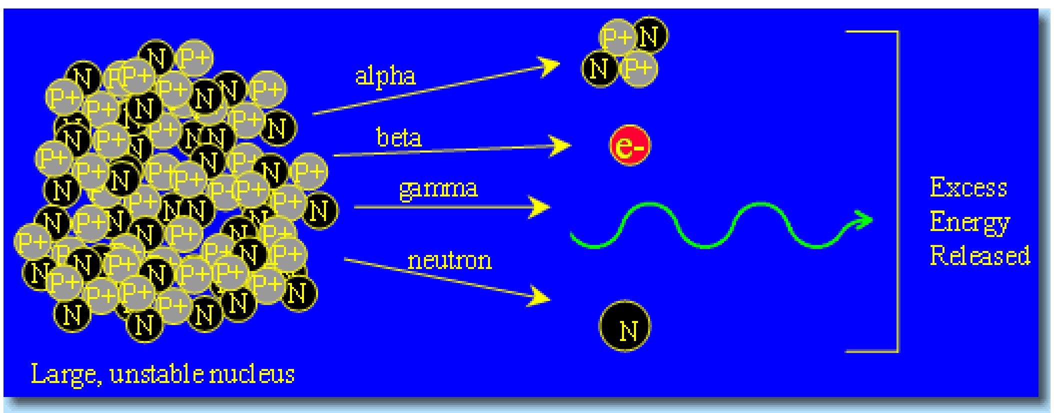
b. Define mass defect and binding energy and discuss their relationship.

When nuclear masses are measured and compared with the masses of the constituent nucleus in free state, the mass of the nucleus is always less than that of the mass of the constituent nucleons. This difference in mass, Δm, is known as the mass defect. In Einstein's mass energy equation, $E = \Delta mc^2$ where Δm = mass defect, the mass defect Δm which is lost in the formation of stable nucleus is converted into energy. This amount of energy must be released when nucleons are combined to form a stable nucleus. This is the binding energy that holds the nucleons in a nucleus so that despite strong repulsive forces between protons they are forced to unite in the nucleus.

c. Describe the following processes, and trace the decay chain for a specified nuclide on the chart of the nuclides:

- **Alpha decay**
- **Beta-minus decay**
- **Beta-plus decay**
- **Electron capture**

Unstable nuclide can release energy by several mechanisms, i.e., alpha decay, beta decay, expulsion of a neutron, or emitting gamma rays.

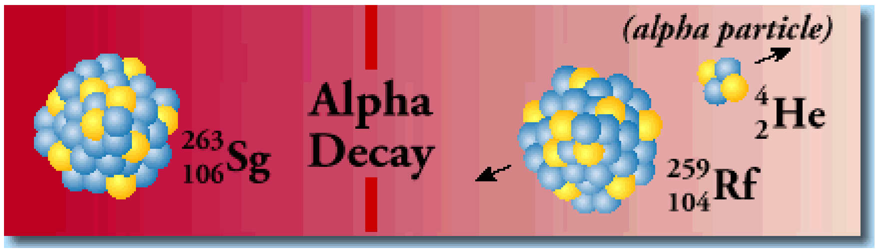


Alpha Decay

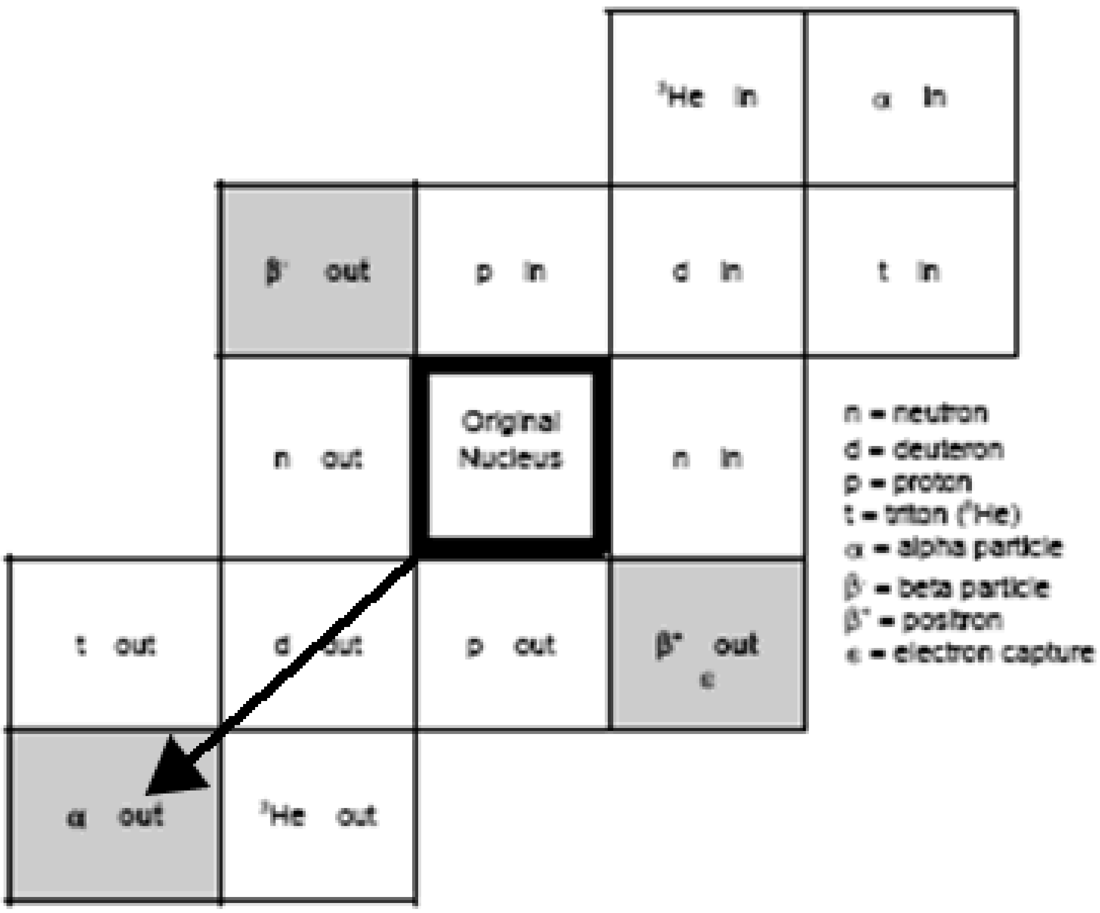
The emission of an alpha (α) particle, or He-4 nucleus, is a process called α decay. Since α particles contain protons and neutrons, they must come from the nucleus of an atom. The nucleus that results from alpha decay will have a mass and charge different from those of the original nucleus. A change in the nucleus's charge means that the element has been changed into a different element.

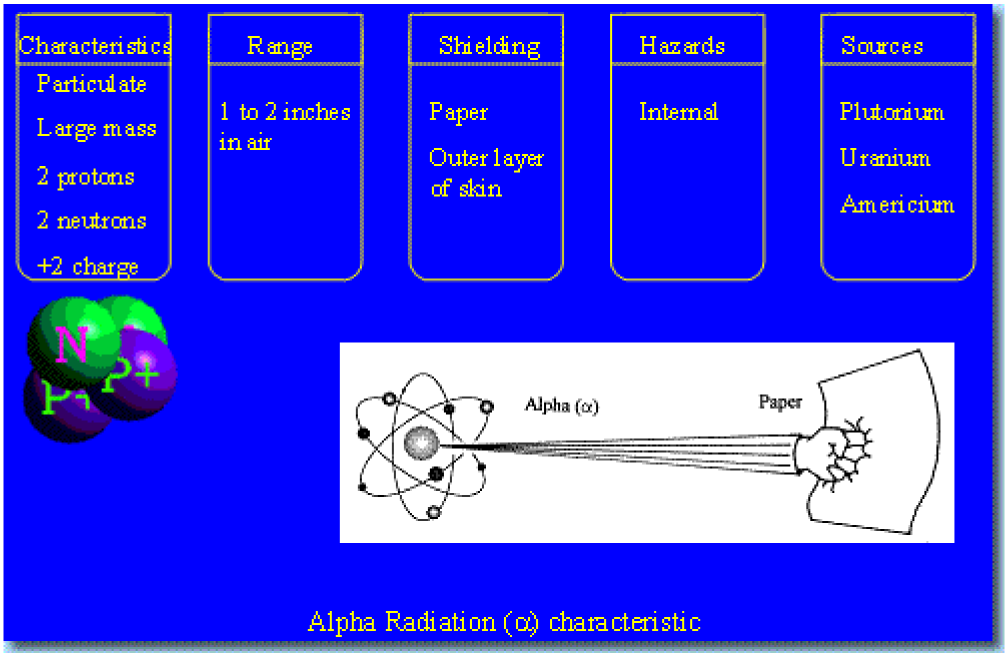
Alpha Decay Example

The mass number, A, of an α particle is four, so the mass number, A, of the decaying nucleus is reduced by four. The atomic number, Z, of $_2He^4$ is two, and therefore the atomic number of the nucleus, the number of protons, is reduced by two. This can be written as an equation analogous to a chemical reaction. For example, for the decay of an isotope of the element seaborgium, $_{106}Sg^{263}$, $_{106}Sg^{263}$-----> $_{104}Rf^{259}$ + $_2He^4$. The atomic number of the nucleus changes from 106 to 104, giving rutherfordium an atomic mass of 263 – 4 = 259. Alpha decay typically occurs in heavy nuclei where the electrostatic repulsion between the protons in the nucleus is large. Energy is released in the process of alpha decay. Careful measurements show that the sum of the masses of the daughter nucleus and the α particle is a bit less than the mass of the parent isotope. Einstein's famous equation, $E = mc^2$, which says that mass is proportional to energy, explains this fact by saying that the mass that is lost in such decay is converted into the kinetic energy carried away by the decay products.



Nuclear interactions (including decays) can be shown as a change of position in the table of isotopes. The Alpha decay results in a change of the position (two down and two to the left) reflecting a decrease in two neutrons and two protons.

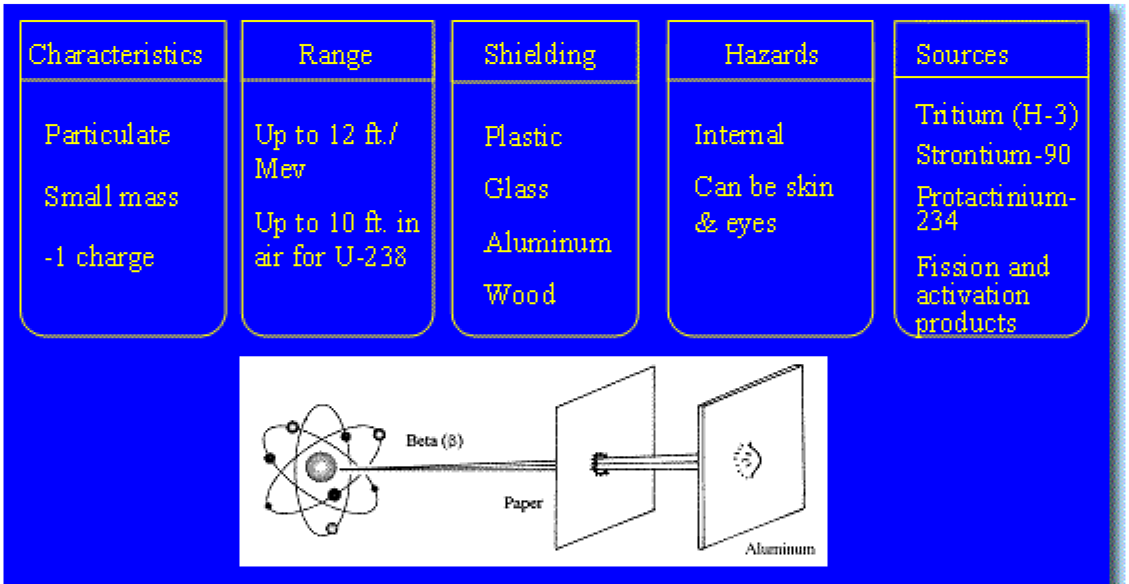




Beta (ß) Particles

Beta (ß) particles are particulate radiation emitted from the nucleus of an unstable atom. The beta particle has the mass of an electron and can have a negative charge of –1 (beta minus) or a positive charge of +1 (beta plus). Since the mass of an electron is a tiny fraction of an atomic mass unit, the mass of a nucleus that undergoes ß decay is changed by only a tiny amount. The mass number is unchanged. The nucleus contains no electrons.

ß minus decay occurs when a neutron is changed into a proton within the nucleus. An unseen neutrino, η, accompanies each ß minus decay. The number of protons, and thus the atomic number, is increased by one.



Beta Radiation (β) characteristics

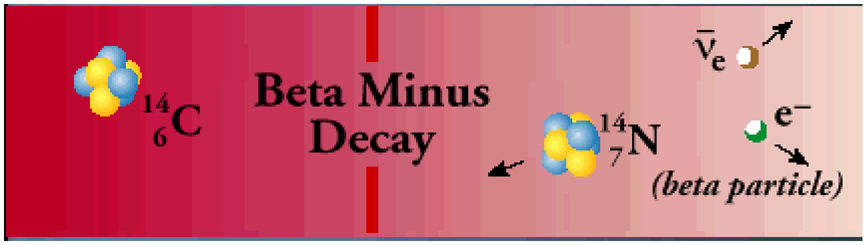
Beta Decay Example

For example, the isotope $_6C^{14}$ is unstable and emits a ß particle, becoming the stable isotope $_7N^{14}$.

The source of the energy released in ß decay is explained by the fact that the mass of the parent isotope is larger than the sum of the masses of the decay products. Mass is converted into energy just as Einstein predicted.

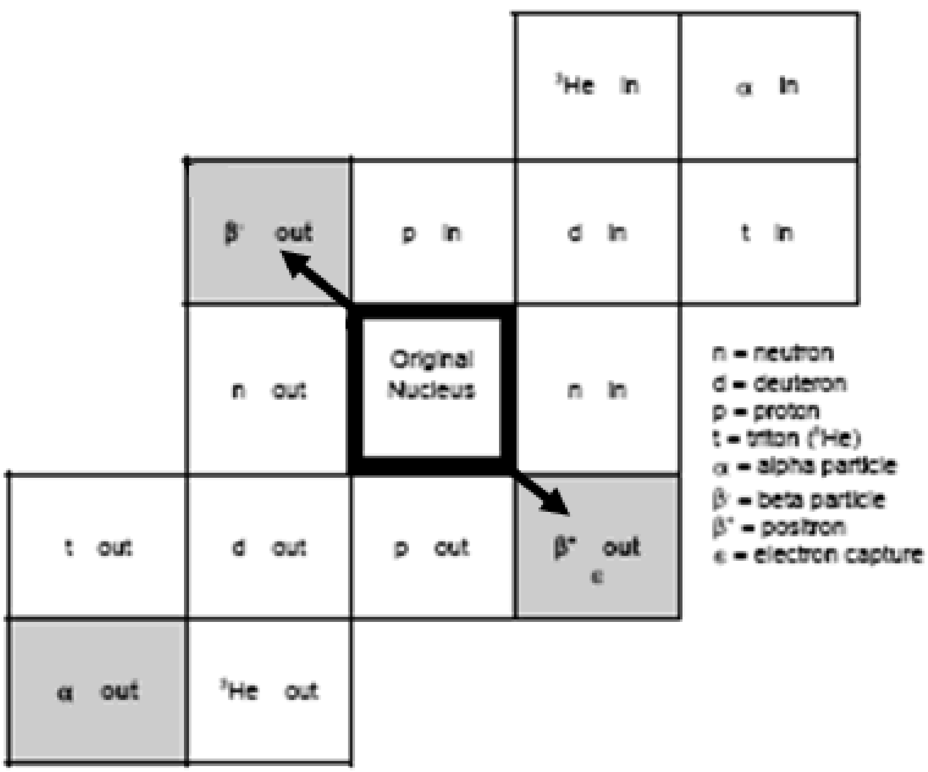
During beta-plus decay, a proton in an atom's nucleus turns into a neutron, a positron, and a neutrino. The positron and neutrino fly away from the nucleus, which now has one less proton than it started with. Since an atom loses a proton during beta-plus decay, it changes from one element to another. For example, after undergoing beta-plus decay, an atom of carbon (with 6 protons) becomes an atom of boron (with 5 protons).

Although the numbers of protons and neutrons in an atom's nucleus change during beta decay, the total number of particles (protons + neutrons) remains the same. For example, after undergoing beta-minus decay, an atom of carbon (with 6 protons) becomes an atom of nitrogen (with 7 protons). During beta-plus decay, a proton in an atom's nucleus turns into a neutron, a positron, and a neutrino. The positron and neutrino fly away from the nucleus, which now has one less proton than it started with. Since an atom loses a proton during beta-plus decay, it changes from one element to another. For example, after undergoing beta-plus decay, an atom of carbon (with 6 protons) becomes an atom of boron (with 5 protons). Although the numbers of protons and neutrons in an atom's nucleus change during beta decay, the total number of particles (protons + neutrons) remains the same.



Beta minus decay results in a change in position one up and one to the left in the table of isotopes (reflecting a loss of a neutron and a gain of a proton in the nucleus [neutron losses an electron and changes into a proton]).

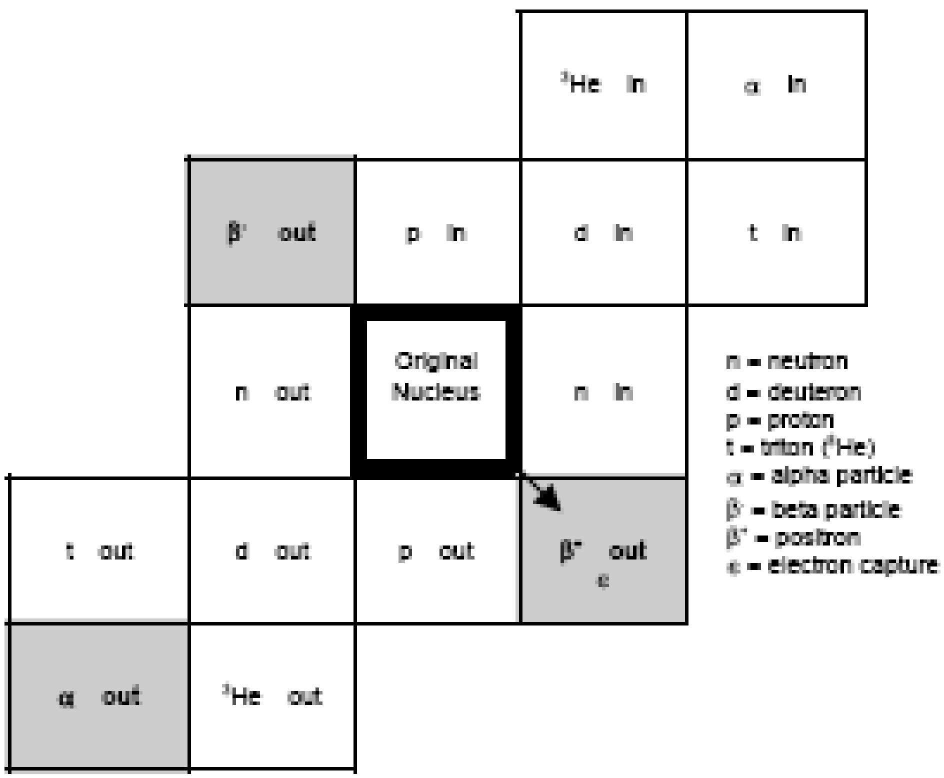
Beta plus decay results in a change in position one down and one to the right in the table of isotopes (reflecting a gain of a neutron and a loss of a proton in the nucleus [proton losses an electron and changes into a neutron]).



Electron Capture

Another way that the nucleus of an atom with too few neutrons may gain one more neutron is to capture one of the negatively charged electrons orbiting about the nucleus. This effectively cancels the positive charge on one of the protons, turning it into a neutron. This process is called electron capture.

Electron capture results in a change in position one down and one to the right in the table of isotopes (similar to a beta plus decay).



d. Define the following terms:

- **Radioactivity**
- **Radioactive decay constant**
- **Activity**
- **Radioactive half-life**
- **Radioactive equilibrium**

Discovery of Radioactivity

In 1896, Henri Becquerel was working with compounds containing the element uranium. He found that photographic plates covered to keep out light became fogged, or partially exposed, when these uranium compounds were anywhere near the plates. This fogging suggested that some kind of ray had passed through the plate coverings. Several materials other than uranium were also found to emit these penetrating rays. Materials that emit this kind of radiation are said to be radioactive and to undergo radioactive decay.

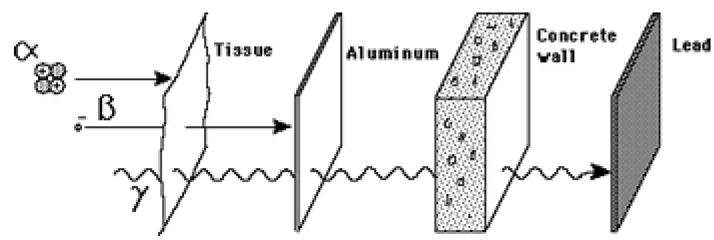
Definition of Radioactivity

Radioactivity is defined as the spontaneous decay or disintegration of an unstable atomic nucleus accompanied by the emission of radiation.

Properties of Radioactive Material

In 1899, Ernest Rutherford discovered that uranium compounds produce three different kinds of radiation. He separated the radiations according to their penetrating abilities and named them α, ß, γ (gamma) radiation, after the first three letters of the Greek alphabet.

The α radiation can be stopped by a sheet of paper. Rutherford later showed that an alpha particle is the nucleus of a He atom, $_2He^4$. Beta particles were later identified as high-speed electrons. Six millimeters of aluminum are needed to stop most ß particles. Several millimeters of lead are needed to stop γ rays, which proved to be high-energy photons. Alpha particles and γ rays are emitted with a specific energy that depends on the radioactive isotope. Beta particles, however, are emitted with a continuous range of energies from zero up to the maximum allowed for by the particular isotope.



Radioactive Decay Constant

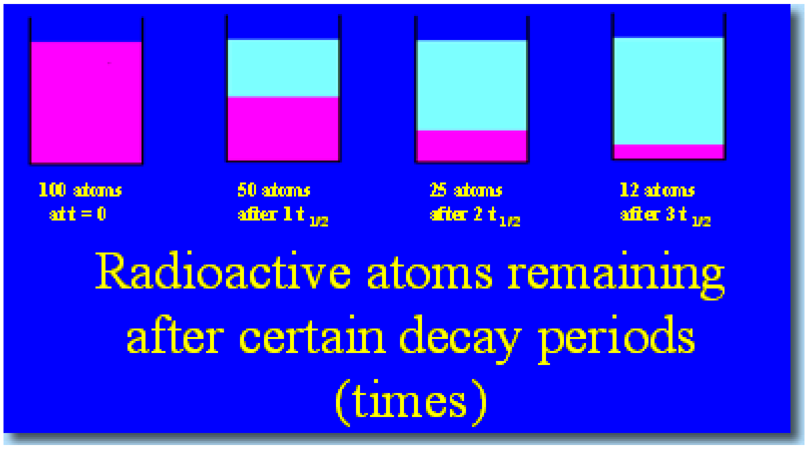
The radioactive decay constant, lambda (λ) is the probability that an atom of a specific radioactive isotope will decay per unit time. The units for radioactive decay constant are inverse time such as 1/sec, 1/hr, 1/yr, etc. For a given number of atoms (N) of a radioactive isotope, the activity (A) is given by the expression $A = \lambda N$. The activity of a pure radionuclide depends on the radioactive decay constant and the initial activity (A_0), and it decreases exponentially as a function of time, according to the expression
$A(t) = A_0 e^{-\lambda t}$.

Activity

The rate of decay of a radioactive substance constitutes the quantity of radioactivity, or activity, in that substance. The definition of activity refers to the number of transformations (disintegrations) per unit time. Since the fundamental unit of time is the second, the quantity activity is measured in disintegrations per second, or dps. Since the second is a very short time period in which to make a measurement, activity is measured in units of disintegrations per minutes, or dpm.

Radioactive Half-Life

The time required for half of the atoms in any given quantity of a radioactive isotope to decay is the half-life of that isotope. Each particular isotope has its own half-life. For example, the half-life of 238U is 4.5 billion years. That is, in 4.5 billion years, half of the 238U on earth will have decayed into other elements. In another 4.5 billion years, half of the remaining 238U will have decayed. One fourth of the original material will remain on earth after 9 billion years. The half-life of 14C is 5,730 years, thus it is useful for dating archaeological material. Nuclear half-lives range from tiny fractions of a second to many, many times the age of the universe.



Radioactive Equilibrium

Radioactive equilibrium for a decay chain occurs when the each radionuclide decays at the same rate it is produced. At equilibrium, all radionuclides decay at the same rate. Understanding the equilibrium for a given decay series helps scientists estimate the amount of radiation that will be present at various stages of the decay.

Example

For example, as 238U begins to decay to 234Th, the amount of thorium and its activity increase. Eventually the rate of thorium decay equals its production. Its concentration then remains constant. As thorium decays to 234Pa, the concentration of 234Pa and its activity rise until its production and decay rates are equal. When the production and decay rates of each radionuclide in the decay chain are equal, the chain has reached radioactive equilibrium. Equilibrium occurs in many cases. However, if the half-life of the decay product is much longer than that of the original radionuclide, equilibrium cannot occur.

e. Describe the following neutron/nucleus interactions:

- **Elastic scattering**
- **Inelastic scattering**

Elastic Neutron Scattering

The sum of the kinetic energy of the particle (neutron) and target (e.g., nucleus) before and after the collision is constant. Essentially, the elastic collision is similar to the collision of billiard balls.

Elastic scattering of neutrons with light nuclei is effective at lowering the kinetic energy of the neutron because much of the energy is transferred to the light nuclei (this is called moderating).

Inelastic Scattering

A neutron may strike a nucleus and form a compound nucleus instead of bouncing off as in elastic scattering. This nucleus is unstable and emits a neutron of lower energy together with a gamma photon that takes up the remaining energy. This process, called inelastic scattering occurs mostly at high neutron energies in heavy materials, but at lower energies elastic scattering becomes a more important reaction for neutron energy loss provided there are light nuclei present. Light nuclei material (such as water and graphite) is used to moderate neutrons in nuclear reactors to enhance nuclear fission.

f. Compare and contrast capture (absorption), fission, and particle ejection nuclear reactions.

Capture (Absorption) Reactions

Most absorption reactions result in the loss of a neutron coupled with the production of a charged particle or gamma ray. When the product nucleus is radioactive, additional radiation is emitted at some later time. Radiative capture, particle ejection, and fission are all categorized as absorption reactions.

Particle Ejection

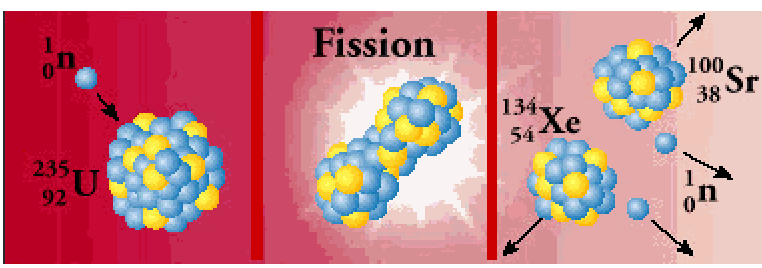
Particle ejection occurs when a neutron is absorbed by a target nucleus, resulting in the formation of a compound nucleus. The compound nucleus immediately ejects a particle (for example, alpha or proton).

Nuclear Fission

Nuclear fission is a process in which an atom splits and releases energy, fission products, and neutrons. The neutrons released by fission can, in turn, cause the fission of other atoms. This is described in greater detail under competency 2.

Radiative Capture

Radiative capture is the absorption of a neutron by the target nucleus, resulting in an excited nucleus that subsequently releases its excitation energy in the form of a gamma ray. Therefore, gamma radiation is produced in the shielding of neutrons.



References: DOE-HDBK-1019-93, vol. 1 and 2, *Nuclear Physics and Reactor Theory*

2. Personnel shall demonstrate a familiarity level knowledge of the basic fission process and results obtained from fission.

Background: Basic Fission Process

Fission

Fission is a nuclear process in which a heavy nucleus splits into two smaller nuclei. An example of a fission reaction that was used in the first atomic bomb and is still used in nuclear reactors is

235U + n ----> 134Xe + 100Sr + 2n.

The products shown on the right hand side in the above equation (fission fragments and neutrons) are only one set of many possible product nuclei. Fission reactions can produce any combination of lighter nuclei so long as the number of protons and neutrons in the products sum up to those in the initial fissioning nucleus. The fission of one uranium atom releases about 200 million electron volts, the large portion of which is the kinetic energy released as heat due to friction when fission fragments slow down and give up their energy within a short distance from the fission site.

Fission is a process that has been occurring in the universe for billions of years. Fission is not only used to produce energy for nuclear bombs, it is also used peacefully everyday to produce energy in nuclear power plants.

Energy Release

A great amount of energy can be released in fission because for heavy nuclei, the summed masses of the lighter product nuclei are less than the mass of the fissioning nucleus.

a. Explain the fission process using the liquid drop model.

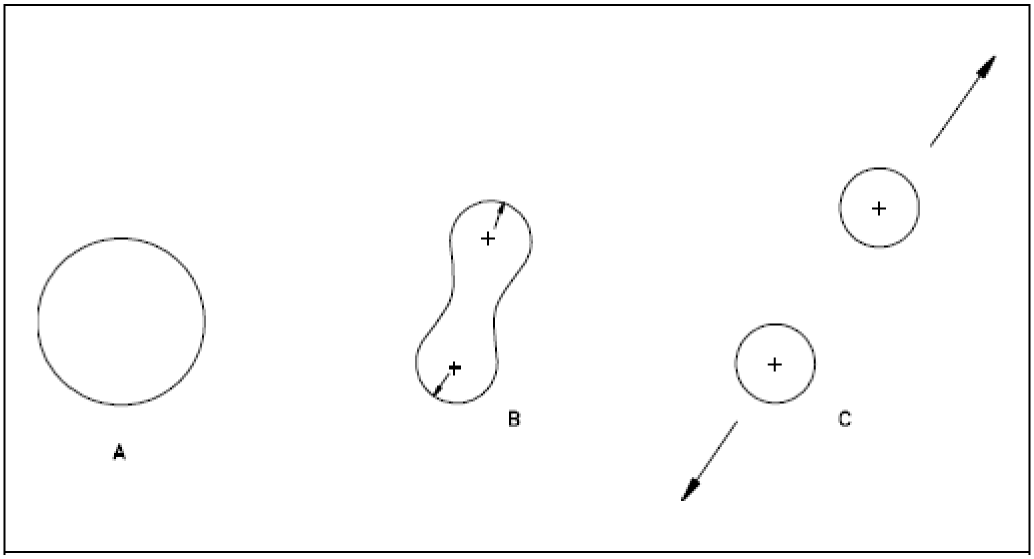
The nucleus is held together by the attractive nuclear force between nucleons. The characteristics of the nuclear force are listed below.

- very short range, with essentially no effect beyond nuclear dimensions (10-13 cm)
- stronger than the repulsive electrostatic forces within the nucleus
- independent of nucleon pairing, in that the attractive forces between pairs of neutrons are no different than those between pairs of protons or a neutron and a proton
- saturable, that is, a nucleon can attract only a few of its nearest neighbors

One theory of fission considers the fissioning of a nucleus similar in some respects to the splitting of a liquid drop. This analogy is justifiable to some extent by the fact that a liquid drop is held together by molecular forces that tend to make the drop spherical in shape and that try to resist any deformation in the same manner as nuclear forces are assumed to hold the nucleus together.

By considering the nucleus as a liquid drop, the fission process can be described.

Referring to (A) in the figure below, the nucleus in the ground state is undistorted, and its attractive nuclear forces are greater than the repulsive electrostatic forces between the protons within the nucleus.



When an incident particle (in this instance a neutron) is absorbed by the target nucleus, a compound nucleus is formed. The compound nucleus temporarily contains all the charge and mass involved in the reaction and exists in an excited state. The excitation energy added to the compound nucleus is equal to the binding energy contributed by the incident particle plus the kinetic energy possessed by that particle. Element (B) in the figure illustrates the excitation energy thus imparted to the compound nucleus, which may cause it to oscillate and become distorted. If the excitation energy is greater than a certain critical energy, the oscillations may cause the compound nucleus to become dumbbell-shaped. When this happens, the attractive nuclear forces (short-range) in the neck area are small due to saturation, while the repulsive electrostatic forces (long-range) are only slightly less than before. When the repulsive electrostatic forces exceed the attractive nuclear forces, nuclear fission occurs, as illustrated in element (C) of the figure.

b. Compare and contrast the characteristics of fissile material, fissionable material, and fertile material.

Fissile material

Fissile material is any material fissionable by neutrons of any energy, including slow or thermal. The three primary fissile materials are 233U, 235U, and 239Pu.

Fissionable material

Fissionable material is material that can only be fissioned by higher energy neutrons. The term fissionable is frequently but imprecisely used as a synonym for fissile material. 238U and 233U are examples of fissionable material.

Fertile material

Fertile material is material, which is not itself fissile material, but which can be converted into a fissile material by irradiation in a reactor is called fertile material. There are two basic fertile materials, 238U and 232Th. When these fertile materials capture neutrons, they are converted into fissile 239Pu and 233U, respectively.

c. Discuss the various energy releases that results from the fission process.

For fission of uranium or plutonium, energies released are around 200 MeV. The majority of the energy is released in the kinetic energy of the fission fragments and neutrons. Other energy is released via decay of fission products, neutrino energy and prompt gamma energy.

MeV stands for million electron volts and is a measure of energy. It is equivalent to about

10^{-13} Joules. Although this is a very small amount of energy, in a typical commercial nuclear power reactor about 10^{22} of these fissions occur per second resulting in about 1000 mega Joules per second of energy being released (i.e., 1000 megawatts).

Energy released in the fission of a U - 235 nucleus appears in the form given in the following table:

Kinetic Energy of Fission Fragments	168 MeV
Kinetic Energy of Fission Neutrons	5 MeV
Prompt Gamma Ray Energy	7.5 MeV
Decay of Fission Fragments	14.5 MeV
Neutrinos Energy	12 MeV
TOTAL	~207 MeV

d. Define criticality and explain how it is detected.

Nuclear criticality refers to the precise state of an assembly of fissionable material in which one neutron from each fission event causes one subsequent fission. If less than one additional fission results, the assembly is sub-critical. If more than one new fission is caused by each fission, the assembly is supercritical.

On the average, about 2.5 neutrons come from the fission of a 239Pu nucleus. Not all neutrons produced in a fission event interact with other nuclei, however. Almost all the neutrons appear immediately in the fission process (prompt neutrons), but a few, something less than 1 percent, do not. The latter are called delayed neutrons; the delay in their appearance can range from less than a second to almost a minute.

The term critical means that the assembly uses all neutrons, including those delayed, to maintain criticality. The delayed fraction, under this condition, permits convenient control because small changes in the reactivity of a system are manifest with times characteristic of the delay periods. If, however, only the prompt neutrons are necessary for criticality, the system does not have this controllability. Such a system is said to have achieved prompt criticality, and the power output will rise very rapidly.

Criticality is detected by a rise in the radiation field. In the case of an accidental criticality, this rise will be rapid. Some process facilities use neutron detectors, some use gamma detectors.

Criticality Experiments use neutron measurements to precisely monitor the experimental system. If the neutron level is decreasing, the system is subcritical. If the neutron level is increasing, the system is supercritical.

DOE requires that areas were there is a potential for a criticality to occur have criticality detectors and a criticality alarm system. The purpose of a criticality alarm system is to alert personnel in a facility if a criticality accident occurs. Criticality alarm systems are installed in accordance with ANSI/ANS 8.3, "Criticality Accident Alarm System," in facilities where a criticality accident is credible. If a criticality accident occurs, large amounts of neutron and gamma radiation are released.

e. List five factors that affect criticality.

Note: Although the General Technical Qualification question only asks for five factors, nine commonly identified factors are listed below.

The following factors affect criticality:

- Density and concentration
- Moderation
- Reflection
- Neutron absorbers (also known as poison)
- Interaction/separation
- Mass
- Volume
- Geometrical shape
- Enrichment

Density

The quantity of fissionable material required for criticality is dependent on the material density. As the density of a system is reduced, escape (leakage) of neutrons from the material before interaction is more likely and more material is required for criticality.

Moderation

When fissionable material is in solution, or present as finely divided particles, the presence of a neutron moderator, such as water or a hydrocarbon, can effect a significant reduction in the amount of fissile material required for criticality. The interaction of neutrons with light nuclei, such as hydrogen, lithium, beryllium, or carbon, reduces the neutron energy after only a few collisions. Slow neutrons interact more readily with nuclei, and therefore they have a greater probability of causing fission in 235U or 239Pu nuclei. There is an optimum degree of moderation because if the ratio of hydrogen nuclei to uranium nuclei becomes too large, neutron capture in the hydrogen becomes competitive with fission in the uranium.

Reflection

Fissile material can also be surrounded by other material that reflects neutrons back into the fissile volume, increasing their opportunity for nuclear interaction.

Neutron Absorbers

Some materials such as cadmium and boron are effective neutron absorbers. Such neutron absorbers may be used to provide criticality control in vessels of large volume or in locations where many vessels are in close proximity and there is concern about neutron interaction occurring between vessels.

Interaction and Separation

Neutrons can escape one fissile item and cause fission in a nearby fissile item. The number of items, size of the items, and distance between the items all affect this parameter. When items are closer together, neutron leakage is reduced and less material is required for criticality.

Mass

Mass is the amount of fissile material. It is usually reported as the amount of uranium or plutonium in grams or kilograms.

Volume

Volume is the space occupied by the fissile mass and associated materials. Large volumes reduce the neutron leakage and are more likely to be critical.

Geometrical Shape

The shape of an assembly of fissile material is also a significant parameter in preventing criticality. Thin cylinders and thin slabs are less likely to be critical than spheres, cylinders of about the same height and diameter and cubes. As the shape gets closer to a sphere, neutron leakage is reduced and less material is required for criticality.

Enrichment

Enrichment is the amount of fissile isotopes relative to the total amount of the element. Highly enriched uranium has more 235U atoms than uranium ore. The higher the enrichment the less material is required to achieve criticality. Enrichment is usually given as the ratio of the fissile isotope to the total element, in mass percent.

f. Identify the hazards that result from an unwanted criticality.

An unwanted criticality is also referred to as a nuclear criticality accident, which is an unintentional, uncontrolled nuclear fission chain reaction. If a criticality accident occurs, it releases a large amount of energy in the form of radiation and heat. Reactor facilities are designed for intentional, controlled criticalities and therefore have adequate radiation shielding and containment of the fissionable material to ensure worker safety. Because fissionable material processing facilities are not designed with the shielding and containment of a reactor facility, a criticality accident can pose serious health and safety risks to the workers.

g. Explain the double contingency principle as it relates to criticality control.

The double contingency principle states that process designs should incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible. Proper application of the double contingency principle provides assurance that no single error or loss of a control will lead to the possibility of a criticality accident.

h. Discuss the potential hazards associated with accidental/unwanted criticality.

Operations with significant quantities of fissionable materials could present the risk of a criticality accident. A criticality accident may expose workers to high, potentially lethal, levels of neutron and gamma radiation and result in a loss of containment, releasing radioactive isotopes into the environment.

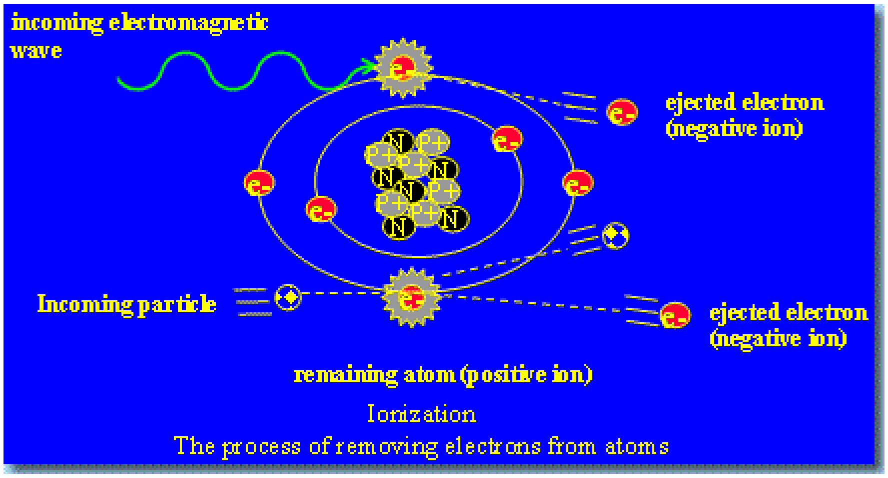
References: DOE-STD-1158-2002, *Self-Assessment Standard for DOE Contractor Criticality Safety Programs*
DOE-HDBK-1019/2-93, *Nuclear Physics and Reactor Theory*
ANSI/ANS-8.3-1986, *Criticality Accident Alarm System*

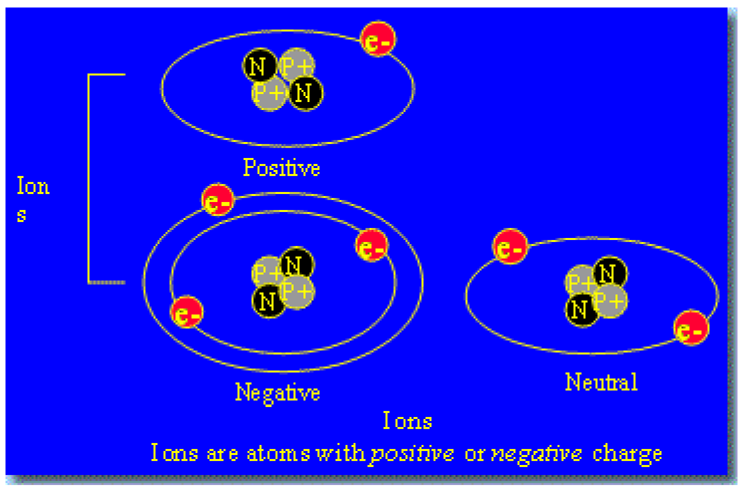
3. Personnel shall demonstrate a familiarity level knowledge of radiological controls and theory.

a. Describe ionizing radiation.

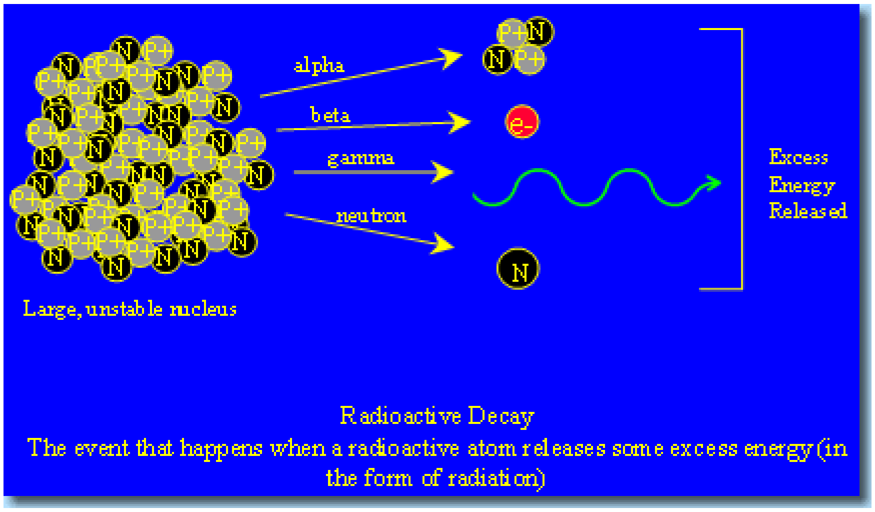
Radiation is defined as the emission and movement of energy through space and or matter. Ionizing radiation is defined as radiation capable of causing the creation of ions as it passes through matter. Ions may be created directly by charged particles (a, b- or b+) interacting with the orbital electrons or they may be created indirectly during reactions involving uncharged particles (n), gamma (g) photons or X-ray photons. Low energy photons (or electromagnetic radiation) such as visible light or AM radio signals do not have enough energy to cause ionization and are referred to as non-ionizing radiation. The distinction between ionizing and non-ionizing radiation is important because ionization is the primary mechanism by which radiation causes biological damage.

In this document we will only discuss ionizing radiation; it will be referred to simply as radiation.





One source of radiation is the nuclei of unstable atoms. For these unstable (radioactive) atoms to become more stable, the nuclei eject or emit subatomic particles and high-energy photons (gamma rays). This process is called radioactive decay. Unstable isotopes of radium, radon, uranium, and thorium, for example, exist naturally. Others are continually being made naturally or by human activities such as the splitting of atoms in a nuclear reactor. Either way, they release ionizing radiation. The major types of radiation emitted as a result of spontaneous decay are alpha and beta particles, and gamma rays. X-rays, another major type of radiation, arise from processes outside of the nucleus.



b. Describe how nuclear radiation is generated.

Nuclear radiation can occur naturally or it can be man-made. Naturally occurring radiation may also be referred to as natural background radiation, and it accounts for the majority of the radiation dose received by the average citizen. The following are three major sources for naturally occurring radiation exposure:

- Cosmic radiation
- Terrestrial radiation (including radon)
- Internal sources

Cosmic Radiation

Cosmic radiation consists of gamma photons and charged particles emitted from the sun and other stars.

Terrestrial Radiation

Terrestrial radiation is radiation originating from material in the earth's crust that contains radioactive elements such as uranium, radium, and thorium.

Internal Sources

Internal sources are naturally occurring radioactive isotopes such as 40K, 14C, and 24Na that are present in food and water.

Radon

Radon is a naturally occurring gas that is produced when radium in the earth's crust undergoes radioactive decay. Radon gas travels up through the soil and tends to collect in buildings and homes. If radon is inhaled and it subsequently decays while in the lungs, it results in a radiation exposure to the lung tissue.

c. Describe each of the following forms of radiation in terms of structure, electrostatic charge, interactions with matter, and penetration potential:

- **Alpha**
- **Gamma**
- **Beta**

- **Neutron (slow and fast)**

Alpha Particles

Alpha particles are energetic, positively charged particles (helium nuclei) that rapidly lose energy when passing through matter. They are commonly emitted in the radioactive decay of the heaviest radioactive elements such as uranium, radium, and by some manmade elements. Alpha particles lose energy more rapidly in matter than most radiation because they are relatively heavy and have an electronic charge of two. Alpha particles do not penetrate very far; however, they can cause damage over their short path through tissue. These particles are usually completely absorbed by the outer dead layer of the human skin, so alpha emitting radioisotopes are not a hazard outside the body. However, they can be very harmful if they are ingested or inhaled. Alpha particles can be stopped completely by a sheet of paper.

Beta Particles

Beta particles are fast moving, positively or negatively charged electrons emitted from the nucleus during radioactive decay. Humans are exposed to beta particles from man-made and natural sources such as tritium, 14C, and 90Sr. Beta particles are more penetrating than alpha particles, but are less damaging over equally traveled distances. Beta particles are more penetrating because they are much smaller and only singly charged and therefore do not interact as strongly. Some beta particles are capable of penetrating the skin and causing radiation damage; however, as with alpha emitters, beta emitters are generally more hazardous when they are inhaled or ingested. Beta particles travel appreciable distances in air, but can be reduced or stopped by a layer of clothing or by a few millimeters of a substance such as aluminum.

Gamma Rays

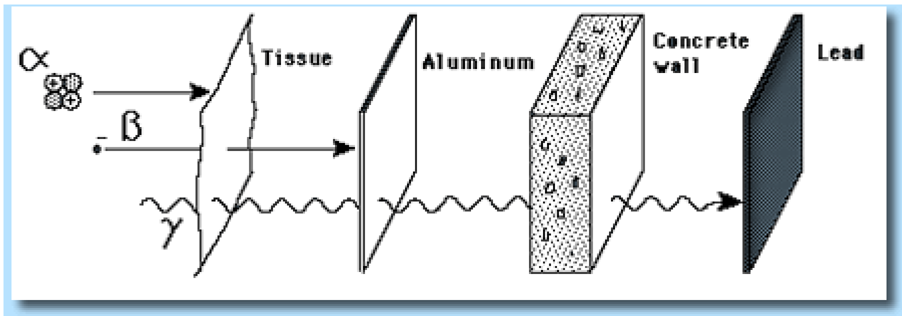
Like visible light and x-rays (that are emitted from the electron shell of an atom), gamma rays (that are emitted from nuclei), are weightless packets of energy called photons. Gamma rays often accompany the emission of alpha or beta particles from a nucleus. They have neither a charge nor a mass and are very penetrating. One source of gamma rays in the environment is naturally occurring 40K. Man-made sources include 239Pu and 137Cs. Gamma rays depending on their energy can easily pass completely through the human body or be absorbed by tissue, thus constituting a radiation hazard for the entire body. Several feet of concrete or a few inches of lead may be required to stop the more energetic gamma rays.

Neutron (Slow and Fast)

Neutrons originate from the nucleus. They do not have an electron charge but are relatively massive as compared to beta particles. They are about ¼ as massive as alpha particles. One large source of neutrons is from nuclear fission (e.g., in nuclear reactors). Neutrons are very penetrating because they lack electronic charge. However, they are also damaging because of their mass. Therefore, when they do interact with an atom they can cause a large amount of ionization. Neutrons are more effectively slowed down when they interact with light atoms (such as water) rather than heavy atoms. Shielding of neutrons generally consist of light nuclei such as water or hydrogenous material.

d. Discuss the types of materials that are best suited for shielding the above radiation types.

Alpha: Any material (e.g., thin paper is effective)
Gamma: Lead or other heavy material
Beta: Clothing or a few millimeters of alumina
Neutron: Light atomic material such as water



e. Describe the biological effects of ionizing radiation (acute and chronic).

Effects of Exposure

The method by which radiation causes damage to human cells is by ionization of atoms in the cells. Atoms make up the cells that make up the tissues of the body. Any potential radiation damage begins with damage to atoms. Potential biological effects depend on how much and how fast a radiation dose is received. Large enough doses can cause immediate health effects up to death. The health effect is proportional to the dose received. Low or moderate exposures can increase the risk of cancer due to damaged cells that are improperly repaired. The probability of a cancer is due to the magnitude of the received dose; however, the severity of the health effect is not correlated to the dose received. There is no detectable difference in appearance between radiation-induced cancers and genetic effects and those due to other causes.

Chronic Exposure

Chronic exposure is continuous or intermittent exposure to low levels of radiation over a long period of time. Chronic exposure is considered to produce only effects that can be observed some time following initial exposure. These include genetic effects and other effects such as cancer, precancerous lesions, benign tumors, cataracts, skin changes, and congenital defects.

Acute Exposure

Acute exposure is exposure to a large, single dose of radiation, or a series of doses, for a short period of time. Large acute doses can result from accidental or emergency exposures or from special medical procedures (radiation therapy). In most cases, a large acute exposure to radiation can cause both immediate and delayed effects. For humans and other mammals, acute exposure, if large enough, can cause rapid development of radiation sickness, evidenced by gastrointestinal disorders, bacterial infections, hemorrhaging, anemia, loss of body fluids, and electrolyte imbalance. Delayed biological effects can include cataracts, temporary sterility, cancer, and genetic effects. Extremely high levels of acute radiation exposure can result in death within a few hours, days, or weeks.

f. Describe the primary hazards (whole body, skin, or internal) of each radiation type.

All people are chronically exposed to background levels of radiation present in the environment. Many people also receive additional chronic exposures and/or relatively small acute exposures. For populations receiving such exposures, the primary concern is that radiation could increase the risk of cancers or harmful genetic effects.

The probability of a radiation-caused cancer or genetic effect is related to the total amount of radiation accumulated by an individual. Based on current regulatory policy, any exposure to radiation is assumed to be harmful (or can increase the risk of cancer); however, at very low exposures, the estimated increases in risk are very small and are indeterminate from the effect of other environmental factors (smog, diet, genetics, etc). For this reason, cancer rates in populations receiving very low doses of radiation may not show increases over the rates for unexposed populations.

The "Linear non-threshold" model has been adopted by DOE as applicable for characterizing the risk of health effects.

g. Discuss radiation dose and how it is measured, including the terms rad, rem, roentgen, and international standard units (SI), and how it is measured.

Radiation dose is a measure of the effect of radiation on a material. Different units are used depending upon the effect and material being considered.

Roentgen is a measure of exposure (in air) and applies only to x and gamma radiation (indirectly ionizing radiation).

Rad (from radiation absorbed dose) is a measure of the amount of energy from all types of radiation imparted to matter.

Rem (from radiation equivalent man) takes into account the ability of the specific type of radiation in causing damage to living tissue.

SI Units

Gray (Gy) is the SI unit for rad: 100 rads equal one gray.
Sievert (Sv) is the SI unit for rem: 100 rem equals one sievert.

Biological Effect

A measurement of energy absorbed per unit mass does not tell the entire story, however. A relative biological factor qualify factor (Q) takes into account the energy absorbed (dose) and the biological effect on the body due to the different types of radiation. This factor is used to convert absorbed dose to effective dose (rem). The quality factor ranges from 1 to 20.

Sievert

One sievert is equal to one gray multiplied by a relative biological effective factor, Q, and a factor that takes into account the distribution of the radiation energy, N. Specifically, if E represents the radioactive dose equivalent in sieverts, and D is the absorbed dose in grays, then E = QND.

Correct Units Usage

The sievert is the correct unit to use when you wish to monitor the biological danger of radiation.

The gray is the correct unit to use when you wish to monitor energy absorbed per unit mass. Prior to the sievert, the unit used to monitor the biological effectiveness of radiation was called the rem, short for roentgen equivalent man. Similar to the difference between the rad and the gray, the difference between the rem and the sievert is a proportionality factor: 100 rems equal one sievert.

Note: Non SI units are still used in the United States.

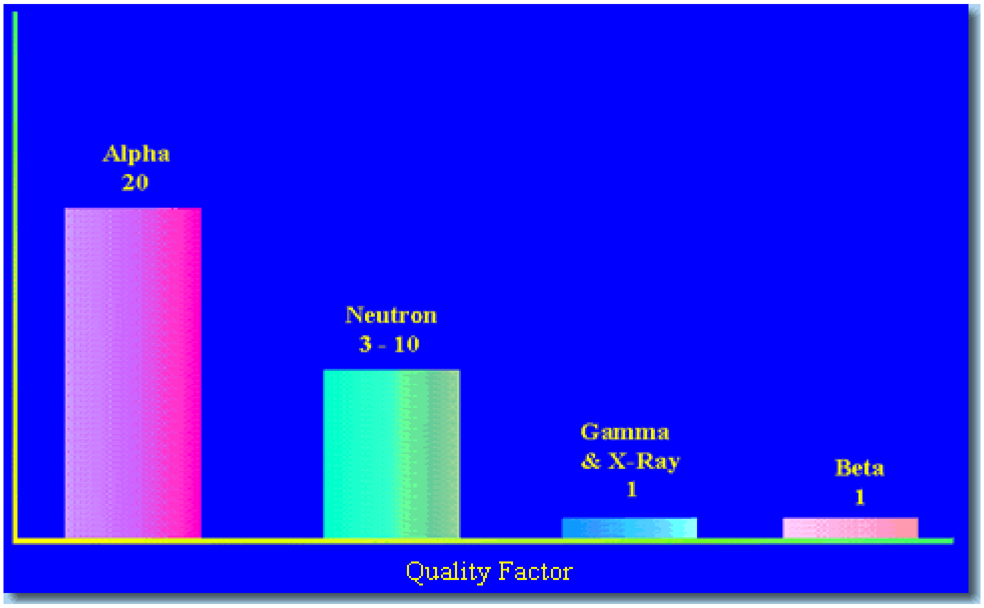
Furthermore, roentgen is used to define the amount of charge produced in a cubic centimeter of air by indirectly ionizing radiation only (X and gamma). It is a very important concept for instrumentation purposes.

h. Define the term "quality factor" and discuss its application to radiation.

The quality factor is a dimensionless numerical value given to each type of radiation based upon its potential to cause biological damage. As stated above, the Q is used to relate the absorbed dose to the dose equivalent. Thus, rem = Q x rad or for SI units, Sv = Q x Gy.

Approximate Quality Factors for Various Forms of Radiation.

Type of radiation	Quality factor (Q)	Absorbed dose equal to a unit dose equivalent
X-, gamma, or beta radiation	1	1
Alpha particles, multiple-charged particles, fission fragments and heavy particles of unknown charge	20	0.05
Neutrons of unknown energy	10	0.1
High-energy protons	10	0.1



i. Discuss the meaning of ALARA and describe the basic methods for achieving ALARA.

As Low As is Reasonably Achievable (ALARA)

ALARA is an approach used for radiation protection to manage and control exposures (individual and collective to the work force and to the general public) and releases of radioactive material to the environment so that the levels are as low as is reasonable taking into account social, technical, economic, practical, and public policy considerations. As used in 10 CFR 835, Occupational Radiation Protection, ALARA is not a dose limit, but a process whose objective is attaining doses as far below the applicable limit of this part as is reasonably achievable.

Engineering controls should be the primary method to control exposure (e.g., enclosed hoods). Administrative controls should be the next method to control exposures (e.g., postings). Personnel protective equipment is the last method (e.g., respirators).

Basic Protective Measures (external dose)

Basic protective measures used to minimize external dose include

- minimizing time in radiation areas;
- maximizing the distance from a source of radiation;
- using shielding whenever possible;
- reducing the amount of radioactive material (source reduction);
- reducing the time spent in a field of radiation;
- staying as far away as possible from the source of radiation;
- shielding to reduce the amount of radiation dose to the worker;
- reducing radiation doses by source reduction.

Basic Protective Measures (internal dose)

Basic protective measures to minimize internal radiation include

- containment
- ventilation
- filtration

As previously stated, install or use engineering controls followed by administrative controls as the primary methods to control internal exposure. Personal protective equipment is the last choice for controlling internal exposure.

Reviewing lessons learned from your site or other sites to demonstrate what may be learned from mistakes leading to excessive personnel exposures.

j. Discuss the hazards ,safe handling, storage requirements, and operational practices for each of the following nuclides in their various forms:

- **Plutonium**
- **Uranium**
- **Tritium**

The following information related to hazards associated with Pu is taken from DOE-HDBK-1145-2001**:**

> Gamma and X-Ray Radiation
>
> All plutonium nuclides emit large quantities of low-energy x-rays, and the "in growth" of Am-241 emits higher-energy gamma rays. These contribute to external exposure and especially extremity exposure. (p.10)
>
> Neutron Radiation
>
> Several plutonium nuclides emit neutron radiation through spontaneous fission (notably from Pu-238, Pu-240, and Pu-242). The rate at which these neutrons are emitted is different with different nuclides of the plutonium. Neutron radiation is also produced by an alpha-neutron reaction. When alpha particles interact with the nucleus of an atom of a lighter element (such as beryllium or lithium), the nucleus is left in an excited state. To return to the ground state, the atom emits a neutron with an energy of about 2.5 MeV. An alpha particle emitted by a plutonium atom may penetrate the nucleus of a fluorine atom in the compound PuF4. The excited nucleus decays by emitting a neutron. The neutron yield and energy of the alpha neutron reaction are dependent on the alpha energy and the material. (p.10)
>
> Criticality
>
> A criticality event can produce a life-threatening dose of radiation to those who are in the immediate vicinity. Example: A burst of 1018 fissions in a metal system may produce doses of 600 rad up to a distance of 30 feet and 100 rad up to around 70 feet (assuming there is no shielding). Also, there may be enough heat generated to melt the system containing the plutonium. The

fission products produced will create residual contamination and lasting radiation problems. (p.11)

Internal Exposure Hazards

Plutonium is a heavy metal that is chemically toxic as well as radioactive. Many other heavy metals such as arsenic, lead, and uranium are also chemically toxic. Plutonium is primarily an alpha emitter and is particularly hazardous if taken into the body. Alpha particles do not travel far in material, which means they lose all of their energy in a short distance. Alpha particles cannot penetrate the dead layer of skin on the body. However, when they are in direct contact with our living cells, such as in our lungs, they are a hazard. Other alpha emitters include natural radon, which is also an inhalation concern. (p.11)

The following information related to hazards associated with U is taken from DOE STD-1136-2004:

The predominant hazard associated with uranium exposure depends on its degree of enrichment, its chemical form, and its physical form. The degree of enrichment determines the gamma radiation intensity and the overall specific activity. (p.2-25)

Because inhalation of uranium potentially poses both radiological and toxic hazards, one must determine which hazard is most limiting and whether or not either hazard can be ignored under certain circumstances. When radiological hazards are limiting, chemical hazards can generally be neglected, except in overexposure situations. When chemical hazards are limiting, radiological hazards can be neglected only if radiation doses are below regulatory concern. Radiological monitoring is required by DOE for individuals who are likely to exceed 100 millirem CEDE in a year. Therefore, it is prudent to calculate organ doses and CEDE for all confirmed intakes, since additional exposures in the same year may result in a total dose exceeding the mandatory individual monitoring threshold. Even in low-potential exposure level situations, a comprehensive dosimetry/control program can prove invaluable in public relations concerning possible future legal litigation. (p.2-27)

The principal industrial hazards associated with uranium are fires, hydrogen generation, generation of oxides of nitrogen, and associated mechanical hazards characteristic of heavy objects, i.e., back injuries from lifting, dropping heavy parts on feet, etc. Hydrogen fluoride and oxides of nitrogen are by-products or reactants of common chemical processes. Hydrogen can be generated by reaction of water with uranium metal, and finely divided uranium or uranium chips with a large surface area to volume ratio can ignite spontaneously. (p.2-31)

Solubility is of major importance in uranium inhalation toxicology. Soluble uranium compounds are absorbed and rapidly transported to kidney and bone, or excreted in urine. Because uranium damages kidney tissues by the same mechanisms as other heavy metals, dissolved uranium is considered to be a chemical toxicant. Dissolved uranium also deposits in bone and is retained for long periods of time, such that sufficiently enriched uranium can deliver an accumulated radiation dose sufficient to be considered a radiological hazard to bone. (p.5-8)

The following information related to hazards associated with tritium is taken from DOE-HDBK-1105-2002:

Abnormal conditions in a tritium facility could include

- fire/explosion
- natural disaster
- tritium releases
- other hazards

Personnel found contaminated should follow site specific decontamination procedures which would typically include showering with cold water and the use of mild detergents. (p.27)

References: DOE-STD-1098-99, *Radiological Control*
DOE-HDBK-1105-2002, *Radiological Training for Tritium Facilities*
DOE-HDBK-1122-99, *Radiological Control Technical Training*
DOE-HDBK-1131-98, *General Employee Radiological Training*
DOE-HDBK-1130-98-CN2, *Radiological Worker Training*
DOE-HDBK-1136-2004; *Guide 0f Good Practices for Occupational Radiological Protection in Uranium Facilities*
DOE-HDBK-1145-2001, *Radiological Training for Plutonium Facilities*
10 CFR 835, "Occupational Radiation Protection"

4. Personnel shall demonstrate a familiarity level knowledge of contamination control and theory.

a. Define the term "contamination" and list three types of contamination.

Radioactive contamination is the presence of radioactive material in an unwanted place. Radioactive contamination can be fixed, removable, or airborne.

Fixed contamination

Fixed contamination is contamination that cannot be easily removed from surfaces. It cannot be removed by casual contact. It may be released when the surface is disturbed (e.g., buffing, grinding, using volatile liquids for cleaning, etc.). Over time it may weep, leach, or otherwise become loose or removable.

Removable contamination

Removable contamination is contamination that can easily be removed from surfaces. Any object that comes in contact with it may become contaminated. It may be transferred by casual contact, wiping, brushing, or washing.

Airborne contamination

Airborne contamination is contamination suspended in air. Air movement across removable contamination could cause the contamination to become airborne.

b. Describe three ways to control contamination.

The three ways to control contamination are

- prevention,
- engineering controls, and
- personal protective equipment.

Prevention

- Establish a solid routine maintenance program for operating systems to minimize failures and leaks that lead to contamination.
- Repair leaks as soon as identified to prevent a more serious problem.
- Stage areas to prevent contamination spread from work activities.
- Cover piping/equipment below a work area to prevent dripping contamination onto cleaner areas.
- Cap contaminated pipes or systems when not in use.
- Minimize the equipment and tools taken into and out of contamination areas.
- Use good housekeeping practices: clean up during and after jobs. Good housekeeping is a prime factor in an effective contamination control program. Each radiological worker should keep his/her work area neat and clean to control the spread of contamination.
- Do not violate contamination area ropes or barricades.
- Do not pass items out of contamination areas without following site procedures.

- Ensure ventilation systems are operating as designed (i.e., no unauthorized modifications).
- Ensure that the proper entry, exit, and equipment control procedures are used to avoid the spread of contamination.
- Comply with procedures.

Engineering Controls

Ventilation

- Systems and temporary spot ventilation (e.g., temporary enclosures with high efficiency particulate air [HEPA] filters) are designed to maintain airflow from areas of least contamination to areas of most contamination (e.g., clean from contaminated to highly contaminated areas).
- A slight negative pressure is maintained on buildings/rooms/enclosures where potential contamination exists.
- HEPA filters are used to remove radioactive particles from the air.

Containment

Permanent and temporary containments are used for contamination control. Examples include vessels, pipes, cells, glove bags, glove boxes, tents, huts, and plastic coverings.

Fixatives

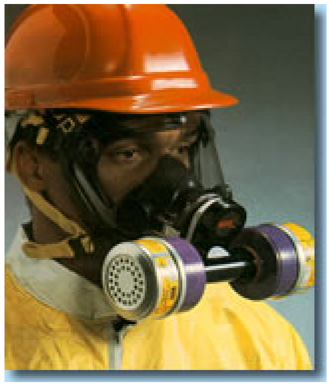
Used to hold contamination in place

Misting

Used to control dust

Personal Protective Equipment

Sometimes engineering controls cannot eliminate contamination. Personal protective measures, such as protective clothing and respiratory equipment, will be used at this point.



Protective clothing

Protective clothing is required for entering areas containing contamination and airborne radioactivity levels above specified limits to prevent personnel contamination.

The amount and type of protective clothing required is dependent on work area radiological conditions and the nature of the job.

Personal effects such as watches, rings, jewelry, etc., should not be worn.

Full protective clothing generally consists of coveralls, cotton liners, rubber gloves, shoe covers, rubber overshoes, and hood.

Respiratory protection equipment

This equipment is used to prevent the inhalation of radioactive materials.

c. Describe how contamination is detected.

Contamination monitoring equipment is used to detect fixed and removable radioactive contamination on personnel and equipment:

- Removable contamination is generally monitored by swiping surfaces with a material and counting the material on a radiation counting device.
- Airborne radioactivity is monitored using specialized equipment that varies depending on the radiation type and if the contamination is particulate or gaseous.

Alpha Continuous Air Monitor Beta Continuous Air Monitor

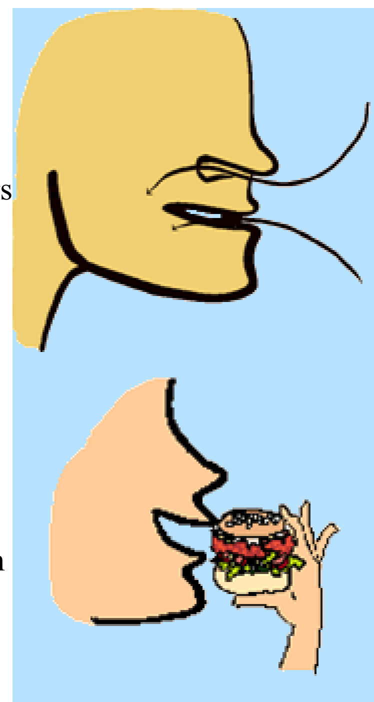
Examples of Monitoring Equipment

Appropriate actions to take if contamination is indicated are to
- remain in the area;
- notify radiological control personnel;
- minimize cross-contamination (e.g., put a glove on a contaminated hand).

d. Describe three ways contamination could enter the body and the methods used to prevent internal contamination.

Note: Although the "knowledge and skills" statement implies that there are three ways, there are actually four ways.

There are four ways that contamination can enter the body is through inhalation, ingestion, absorption and injection (i.e., via a wound).



Inhalation
Internal contamination via inhalation can occur when airborne contamination is breathed in. Methods to reduce and/or prevent contamination are via respirators (e.g., air purifying respirators or positive pressure or demand supplied air respirators).

Ingestion
Internal contamination via ingestion occurs when radioactive material is swallowed. Methods to prevent ingestion include restrictions on eating and drinking in contaminated areas.

Absorption

Internal contamination via absorption occurs when skin comes in contact with radioactive material. Methods to prevent absorption are to cover the skin (e.g., gloves) and not touching uncovered skin with material that may be contaminated (no scratching your nose when in anti-cs).

Injection

Injection of radioactive material can occur when working in a contaminated area with a cut or wound that exposes tissue below the skin. Methods to prevent the injection of radioactive material are to restrict personnel with wounds from working in contaminated areas or covering the wound.

e. Describe the methods used for internal dose determination.

Bioassay samples, lung counting, and wound counting are three methods used in monitoring for internal contamination.

Bioassay

A routine bioassay program is required by 10 CFR 835 for personnel if there is a likelihood that an intake of radioactive material could occur that would exceed specific limits as specified in 835.402 (c).

Bioassay programs use urine samples, fecal samples, and nasal and mouth smears to determine the committed effective dose equivalent (CEDE) from internal contamination. Fecal samples are the most sensitive bioassay method for detecting internal plutonium contamination. The type of bioassay samples collected and the CEDE will depend on many factors such as, the radionuclide involved, the chemical form of the material, the route of entry, and the elapsed time since the intake occurred.

Air Sampling

Worker doses may also be calculated using air sampling data where the area is well understood and good records of all entries are maintained to include duration.

Lung Counters

Lung counters are used to detect inhaled radioactive material in the lungs. The lung counter has a limited capacity for detecting internal contamination because it can only measure gamma rays. The amount of inhaled plutonium must be estimated from the measured amount of gamma rays emitted from americium (plutonium decay product). Lung counts can be used in conjunction with bioassay samples to determine CEDE.

Wound Counters

Wound counters measure gamma and x-rays emitted by radionuclides deposited in a wound. Wound counts are primarily used as a tool to determine if internal contamination of a wound has occurred and to determine the success of subsequent decontamination efforts.

f. Describe the types of personnel protective equipment.

Personnel protective equipment (PPE) used for radiological purposes can be divided into two main types:

- Protection against internal contamination
- Protection against external contamination or sources

Respiratory protection is used to protect personnel from inhaling or ingesting radioactive material. Respirators that supply breathing air or self-contained breathing apparatus are examples of respiratory equipment used to prevent internal contamination. Protection factors are assigned to respiratory protection equipment, which are used to determine the maximum level of airborne radioactive contamination that the equipment can protect against. Examples of equipment used to protect against external contamination or radiation sources include anti-contamination clothing (protection against skin contamination), safety glasses (protection against beta to eyes), lead aprons (protection against gamma to major organs), and lead-lined gloves (protection against skin contamination and gamma to hands). Requirements to use personal protective equipment are included in radiological work permits and on postings at area entry points.

g. Describe the potential effects of radioactive contamination outside contamination areas.

Note: The technical qualification standard inappropriately states "outside of radiation areas." The correct statement is "outside of contamination areas."

Contamination area means any area where contamination levels are greater than the values specified in Appendix D of 10 CFR 835, "Occupational Radiation Protection," but less than or equal to 100 times those levels. Appendix D values range from 20 decays per minute per 100 square centimeter area to 5000 dpm/100 cm2 depending on the radionuclide.

The primary concern is that radioactive contamination above regulatory limits located outside of contamination areas may not have proper controls to prevent its dispersal and may have an adverse health effect on workers or the public.

References: 10 CFR 835, "Occupational Radiation Protection"
DOE-STD-1098-99, *Radiological Control*
DOE HDBK-1122-99, *Radiological Control Technical Training*
DOE-HDBK-1129-99, *Tritium Handling and Safe Storage*
DOE-HDBK-1130-98-CN2; *Radiological Worker Training*
DOE-HDBK-1131-98; *General Employee Radiological Training*

5. Personnel shall demonstrate a familiarity level knowledge of basic radiation detection methods and principles.

a. Describe the proper use and function of and radiation detected by different types of thermoluminescent dosimeters and self-reading dosimetry.

Thermoluminescent Dosimeters

Thermoluminescent dosimeters (TLDs) are used to measure the external radiation dose received by radiation workers (personnel with the potential to receive >100 mrem/yr whole body effective dose equivalent from occupational exposures). A typical whole body dosimeter contains several TLDs.

Each TLD contains material that absorbs and stores the energy of the applicable radiation and when heated gives off the energy as ultraviolet light in proportion to the quantity of radiation exposure received. By measuring the ultraviolet light given off by the TLD, the effective dose equivalent received by the wearer of the TLD can be calculated.

Whole Body Dosimeters

Whole body dosimeters are worn on the chest area between the waist and the neck with the picture (and the beta window) facing out.

Extremity TLDs

In addition to whole body TLDs, extremity TLDs are worn by workers who receive significant dose to their lower arms/hands and lower legs for example those who work in glove boxes or directly handle radioactive materials and must be monitored for extremity exposure by 10 CFR 835.

Self-Reading Dosimeters

Self-reading dosimeters are required for workers entering high or very high radiation areas where they could receive >10% of an administrative control level in one workday.

They are used to measure gamma or x-ray radiation and are used in conjunction with whole body TLDs. The advantage of a pocket ion chamber dosimeter over a whole body TLD is that it can be read by the workers so that they can closely monitor their radiation exposure while they are working in a radiation field. Self-reading dosimeters are worn adjacent to whole body TLDs.

In the past most sites utilized “pocket ion chamber dosimeters” for self-reading dosimeters. Now most sites use electronic self-reading detectors. Some of these detectors also have an alarm feature that will alarm when the detectors reaches an integrated dose reaching an administratively set limit.

b. State the purpose and function of the following radiation monitoring systems:
- **Criticality**
- **Area**
- **Process**
- **Airborne**

Criticality Alarm System

The purpose of a criticality alarm system is to alert personnel in a facility if a criticality accident occurs. Criticality alarm systems are installed in accordance with ANSI/ANS 8.3, Criticality Accident Alarm System, in facilities where a criticality accident is credible. If a criticality accident occurs, large amounts of neutron and gamma radiation are released. The criticality alarm system detects the radiation and activates audible and visual alarms.

Area

The purpose of a real-time area radiation monitoring system is to alert personnel in an area of a facility if the radiation/dose rate in that area increases above a preset level. Area radiation monitoring that is not real-time is meant to identify long-term radiation levels and trends.

Process

The purpose of a process monitoring system is to alert personnel if a process has been jeopardized to the extent that radioactive contamination could result. If set points are exceeded, the process is shutdown and alarms are activated.

References: 10 CFR 835, "Occupational Radiation Protection"
DOE-STD-1098-99, *Radiological Control*
DOE-HDBK-1122-99, *Radiological Control Technical Training*
DOE-HDBK-1130-98-CN2; *Radiological Worker Training*
DOE-HDBK-1131-98, *General Employee Radiological Training*

6. Personnel shall demonstrate a familiarity level knowledge of the requirements documents for radiological control practices, procedures, and limits.

a. Discuss the purpose and general requirements of 10 CFR 835,Occupational Radiation Protection to include the following:
- **Access training**
- **Dose limits**
- **Posting types and use**
- **Access requirements**
- **Differences in radiological terminology between the 1998 and 2007 revisions of 10 CFR 835.**

Access Training

Before being permitted unescorted access to radiological areas, and before performing unescorted assignments as a radiological worker, persons must receive radiation safety training.

Radiation safety training shall include the following topics, to the extent appropriate to each individual's prior training, work assignments, and degree of exposure to potential radiological hazards:

- Risks of exposure to radiation and radioactive materials, including prenatal radiation exposure
- Basic radiological fundamentals and radiation protection concepts
- Physical design features, administrative controls, limits, policies, procedures, alarms, and other measures implemented at the facility to manage doses and maintain doses ALARA, including routine and emergency actions
- Individual rights and responsibilities as related to implementation of the facility radiation protection program
- Individual responsibilities for implementing ALARA measures
- Individual exposure reports that may be requested

Dose Limits

Except for planned special exposures conducted consistent with section 835.204 and emergency exposures authorized in accordance with section835.1302, the occupational dose received by general employees shall be controlled such that the following limits are not exceeded in a year:

- A total effective dose equivalent of 5 rems (0.05 sievert)
- The sum of the deep dose equivalent for external exposures and the committed dose equivalent to any organ or tissue other than the lens of the eye of 50 rems (0.5 sievert)
- A lens of the eye dose equivalent of 15 rems (0.15 sievert)
- A shallow dose equivalent of 50 rems (0.5 sievert) to the skin or to any extremity

All occupational doses received during the current year, except doses resulting from planned special exposures conducted in compliance with section 835.204 and emergency exposures authorized in accordance with section 835.1302, shall be included when demonstrating compliance with sections 835.202(a) and 835.207.

Doses from background, therapeutic and diagnostic medical radiation, and participation as a subject in medical research programs shall not be included in dose records or in the assessment of compliance with the occupational dose limits.

Posting Types and Use

Each access point to a controlled area shall be posted whenever radiological areas or radioactive material areas exist in the area. Individuals who enter only controlled areas without entering radiological areas or radioactive material areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in a year.

Signs used for this purpose may be selected by the contractor to avoid conflict with local security requirements.

Each access point to radiological areas and radioactive material areas shall be posted with conspicuous signs bearing the wording provided in section 835.603.

Radiation area–The words "Caution, Radiation Area" shall be posted at each radiation area.

High radiation area–The words “Caution, High Radiation Area” or “Danger, High Radiation Area” shall be posted at each high radiation area.

Very high radiation area–The words “Grave Danger, Very High Radiation Area” shall be posted at each very high radiation area.

Airborne radioactivity area–The words “Caution, Airborne Radioactivity Area” or “Danger, Airborne Radioactivity Area” shall be posted at each airborne radioactivity area.

Contamination area–The words “Caution, Contamination Area” shall be posted at each contamination area.

High contamination area–The words “Caution, High Contamination Area” or “Danger, High Contamination Area” shall be posted at each high contamination area.

Radioactive material area–The words “Caution, Radioactive Material(s)” shall be posted at each radioactive material area.

Access Requirements

Appropriate controls shall be maintained and verified which prevent the inadvertent transfer of removable contamination to locations outside of radiological areas under normal operating conditions.

Any area in which contamination levels exceed the values specified in appendix D of subpart L of 10 CFR 835 commensurate with the physical and chemical characteristics of the contaminant, the radionuclides present, and the fixed and removable surface contamination levels.

Areas accessible to individuals where the measured total surface contamination levels exceed, but the removable surface contamination levels are less than, corresponding surface contamination values specified in appendix D of 10 CFR 835, shall be controlled as follows when located outside of radiological areas:

- The area shall be routinely monitored to ensure the removable surface contamination level remains below the removable surface contamination values specified in appendix D of 10 CFR 835.
- The area shall be conspicuously marked to warn individuals of the contaminated status.

Individuals exiting contamination, high contamination, or airborne radioactivity areas shall be monitored, as appropriate, for the presence of surface contamination.

Protective clothing shall be required for entry to areas in which removable contamination exists at levels exceeding the removable surface contamination values specified in appendix D of 10 CFR 835.

Differences in Radiological Terminology

1998 Dosimetric Terms	2007 Dosimetric Terms
Committed effective dose equivalent	Committed effective dose

Committed dose equivalent	Committed equivalent dose
Cumulative total effective dose equivalent	Cumulative total effective dose
Deep dose equivalent	Deep equivalent dose
Dose equivalent	Equivalent dose
Effective dose equivalent	Effective dose
Lens of the eye dose equivalent	Lens of the eye equivalent dose
Quality factor	Radiation weighting factor
Shallow dose equivalent	Shallow equivalent dose
Weighting factor	Tissue weighting factor
Total effective dose equivalent	Total effective dose

Source: Federal Register—10 CFR Parts 820 and 835, "Procedural Rules for DOE Nuclear Activities and Occupational Radiation Protection;" "Final Rule"

b. Discuss the purpose and general guidance provided under DOE-STD-1098-99, Radiological Control.

The DOE has developed this standard to assist line managers in meeting their responsibilities for implementing occupational radiological control programs. DOE has established regulatory requirements for occupational radiation protection in 10 CFR 835, "Occupational Radiation Protection," amended 1998. Failure to comply with these requirements may lead to appropriate enforcement actions as authorized under the Price Anderson Act Amendments. While this standard does not establish requirements, it does restate, paraphrase, or cite many (but not all) of the requirements of 10 CFR 835 and related documents (e.g., occupational safety and health, hazardous materials transportation, and environmental protection standards).

To assist its operating entities in achieving and maintaining compliance with the requirements of 10 CFR 835, DOE has established its primary regulatory guidance in the DOE G 441.1 series of guides. The guides are structured to assist radiation protection professionals in developing the documented radiation protection program required by 10 CFR 835.101 and the supporting site- and facility-specific policies, programs, and procedures that are necessary to ensure compliance with the related regulatory requirements. The guides establish a macroscopic view of the various elements of a comprehensive radiation protection program and discuss concepts that the cognizant professionals should consider in developing and implementing the site- and facility-specific programs. This Standard supplements the DOE G 441.1 series of Guides and serves as a secondary source of guidance for achieving compliance with 10 CFR 835. While there is significant overlap between the DOE G 441.1 series of guides and this standard, this standard differs from the guides in intent and detail. In contrast to the macroscopic view adopted by the guides, this standard discusses specific measures that should be implemented by affected line managers, workers, and support staff to ensure proper fulfillment of their radiological control responsibilities. DOE expects that each site will identify the provisions of this standard that support its efforts to implement an effective radiological control program and incorporate these provisions, as appropriate, into the site-specific radiological control manual, site procedures, training, or other administrative instruments that are used to guide employee activities.

References: 10 CFR 835, "Occupational Radiation Protection"

DOE-STD-1098-99, *Radiological Control*
DOE-HDBK-1122-99, *Radiological Control Technical Training*
DOE-HDBK-1130-98-CN2; *Radiological Worker Training*
DOE-HDBK-1131-98; *General Employee Radiological Training*

7. Personnel shall demonstrate a familiarity level knowledge of the sources and types of radioactive and hazardous waste associated with DOE facilities.

a. Discuss the following terms and the differences among them:

- **Low-level radioactive waste**
- **Hazardous waste**
- **Transuranic waste**
- **High-level radioactive waste**
- **Mixed hazardous waste**

Low-Level Radioactive Waste (LLW)

Low-level radioactive waste is radioactive waste that is not high level radioactive waste, spent nuclear fuel, transuranic waste, byproduct material (i.e., uranium and thorium mill tailings or waste from processed ore), or naturally occurring radioactive material. LLW with a hazardous component (e.g., hazardous chemical) is “mixed waste.”

Note: Radioactive waste is defined as any garbage, refuse, sludge, and other discarded material, including solid, liquid, semisolid, or contained gaseous material that must be managed for its radioactive content.

NRC regulations divide LLW into four classes based on physical stability and potential radiation hazard posed to the public if the waste is disposed in a near-surface disposal facility.

- Class A wastes contain low concentrations of radioactive materials and do not present a significant radiological hazard for the public.
    - Class A wastes are usually segregated from other waste classes at the disposal site because they tend to be composed of materials with little physical stability whose deterioration over time could lead to subsidence and threaten the integrity of the disposal system.
- Class B wastes contain significant concentrations of radioactive materials that will be a radiation hazard for up to 100 years.
    - To ensure the integrity of the disposal system, more rigorous waste form stability requirements are applied to Class B wastes than to segregated Class A wastes.
    - Access at a Class B disposal site must be controlled for at least 100 years.
- Class C wastes contain significant concentrations of radioactive materials that will be a radiation hazard for up to 500 years.
    - Class C wastes must meet the same rigorous waste form stability requirements as are applied to Class B wastes.
    - Intruder barriers, such as concrete covers, with an effective life of at least 500 years, must be installed at a Class C disposal site.

Wastes with concentrations of radioactive materials above those allowed in Class C are called "Greater than Class C" wastes and are generally considered unacceptable for near-surface disposal.

While the NRC does not directly regulate DOE low-level wastes or DOE low-level waste disposal facilities, NRC regulations are important because

- some DOE wastes may be disposed or treated at commercial LLW facilities that are regulated by the NRC;
- DOE LLW facilities have adopted waste acceptance criteria that rely on the NRC LLW classification system.

The following are examples of minimum requirements for all classes of waste and are intended to facilitate handling at the disposal site and provide protection of health and safety of personnel at the disposal site:

- Waste must not be packaged for disposal in cardboard or fiberboard boxes.
- Liquid waste must be solidified or packaged in sufficient absorbent material to absorb twice the volume of the liquid.
- Solid waste containing liquid shall contain as little free standing and noncorrosive liquid as is reasonably achievable, but in no case shall the liquid exceed 1% of the volume.
- Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.

Hazardous Waste

Hazardous waste is a waste with properties that make it dangerous, or capable of having a harmful effect on human health and the environment. Under the Resource Conservation and Recovery Act (RCRA) program, hazardous wastes are specifically defined in 40 CFR Part 261 as solid wastes that meet a particular listing description, have been mixed with materials that meet a particular listing description, or exhibit at least one of the four characteristics of hazardous waste, which are toxicity, corrosivity, ignitability, and reactivity. RCRA defines solid waste as any garbage, refuse, sludge, or other discarded material, regardless of whether it is physically solid, liquid, semisolid, or contained gas, unless it is excluded.

Transuranic (TRU) Waste

Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

High-level Radioactive Waste

High-level waste (HLW) is the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.

Note: Unlike the NRC definition, the DOE definition of HLW does not encompass irradiated nuclear fuel. Instead, DOE defines “spent nuclear fuel” as a separate waste category.

Spent Nuclear Fuel

Spent nuclear fuel is fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing.

Mixed Hazardous Waste (Better known as simply mixed waste)

Radioactive waste that contains both source, special nuclear, or by-product material and a hazardous component that is subject to the Resource Conservation and Recovery Act (RCRA) [DOE M 435.1-1].

Note: Any LLW that exhibits a hazardous characteristic or has a component that is a listed hazardous waste would be a mixed waste. Every DOE HLW is mixed waste because all DOE HLW has been determined to either exhibit a hazardous characteristic or contain listed hazardous wastes.

Additional Definitions

Source Material

- Uranium or thorium, or any combination thereof, in any physical or chemical form
- Ores which contain by weight one-twentieth of one percent (0.05%) or more of: (i) uranium, (ii) thorium or (iii) any combination thereof. Source material does not include special nuclear material

Special Nuclear Material

- Plutonium, uranium enriched in the isotope 233 or in the isotope 235, and any other material which is determined, pursuant to the provisions of section 51 [of the Atomic Energy Act of 1954, as amended], to be special nuclear material, but does not include source material; or
- Any material artificially enriched by any of the foregoing, but does not include source material

By-Product Material

- Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and
- The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content

RCRA Waste

The Resource Conservation and Recovery Act includes logic, lists, and analytical test that are useful in determining whether a waste meets the regulatory definition of “hazardous.”

b. Describe potential sources of each of the following types of waste in a DOE facility:
- **Low-level radioactive waste**
- **Hazardous waste**
- **Transuranic waste**
- **High-level radioactive waste**
- **Mixed hazardous waste**

Low-Level Radioactive Waste

At DOE, LLW is generated during processing of nuclear materials used in nuclear weapons production and energy research and development activities.

Examples of LLW include equipment and personal items that have become contaminated with radioactive material, such as protective shoe covers, protective clothing, wiping rags, mops, filters, and tools. Certain process residuals, such as reactor water treatment residues, also may be LLW.

Hazardous Waste

Examples of sources of hazardous waste include the following:
- Maintenance shop activities
  - Acids
  - Solvents
  - Paints
  - Oils
  - Rags contaminated with hazardous cleaning compounds
- Construction or decommissioning activities
  - Metals
  - Contaminated debris
  - Removal of lead-based paints
  - Solvents
- Production Activities
  - Refrigerants
  - Chemicals used in metal plating activities
  - Quenching bath sludge
  - Water treatment

Transuranic Waste

Transuranic waste is generated from plutonium processing in basic special nuclear material research to develop, prove, and implement technology for existing and/or future plutonium processing needs, and from the provision of support to national defense and energy programs.

High-Level Radioactive Waste

In 1992, DOE ceased all chemical reprocessing of spent nuclear fuel, which is the source of HLW. Before 1992, DOE generated HLW at the Hanford Site, the Savannah River Site, and the Idaho National Laboratory. All HLWs generated by DOE are considered mixed wastes. Commercial reprocessing of nuclear power reactor spent fuel was conducted from 1966 through 1972 at the West Valley Demonstration Project site. In 1980, Congress directed DOE to decommission and cleanup the site. The HLW at West Valley has been vitrified and is being stored on site, awaiting disposal in a federal geologic repository.

Spent Nuclear Fuel

Spent nuclear fuel consists of nuclear fuel that no longer has enough fissionable material (usually uranium, but other elements can also be used) to efficiently release nuclear energy in a reactor.

During operation, fissionable atoms split into two or more, smaller and lighter elements—like cesium and strontium. Meanwhile, other uranium atoms do not split but are converted into transuranic elements (beyond uranium on the periodic table of elements) such as plutonium and americium.

Since the new elements do not normally contribute to the generation of energy, the fuel becomes less efficient over time and, at some point, must be removed from the reactor; spent fuel is still extremely radioactive and poses severe health risks if it is not properly contained.

Mixed Hazardous Waste

DOE Low-Level Mixed Waste (LLMW) is generated, projected to be generated, or stored, at 37 DOE sites in 22 states as a result of research, development, and production of nuclear weapons. Waste management activities will require management of an estimated 226,000 m^3 of LLMW over the next 20 years.

Other sources of LLMW at DOE sites are decommissioning and site remediation as well as nuclear energy research and scientific research.

The following are examples of LLMW:

- Radioactively contaminated elemental lead in the form of sheets, lead-lined blankets and gloves, bricks, shot, wire, and other shielding
- Radioactively contaminated lead batteries
- Radioactively contaminated cadmium-, silver-, and mercury
- Elemental mercury contaminated with radioactive material
- Mercury-contaminated hydraulic oil containing radioactive material

Mixed Hazardous Waste (continued)

HLWs are classified as mixed wastes, unless a demonstration showing otherwise has been made, because they are highly corrosive and contain toxic metals. Some HLWs may also contain spent solvents, which meet a listing description in 40 CFR Part 261. HLWs generated by DOE are located at the Hanford Site, the Savannah River Site, and the Idaho National Laboratory. Also, HLW from commercial reprocessing of nuclear power reactor spent fuel is located at the West Valley Demonstration Project Site.

c. Discuss the various types of storage, treatment, and disposal used to manage the following types of waste:

- **Low-level radioactive waste**
- **Hazardous waste**
- **Transuranic waste**

- **High-level radioactive waste**
- **Mixed hazardous waste**

DOE must safely store the wastes generated by its current operations, as well as a significant backlog of waste generated in the past. Storing different types of waste presents the Department's Waste Management Program with a considerable challenge because each type of waste must meet technical and regulatory requirements.

Hazardous chemical waste is generally stored pending treatment, or disposal.

Short-term storage of mixed waste is provided at many facilities for up to 90 days before the wastes are shipped onsite for treatment or disposal. Waste is often stored to accumulate sufficient quantities to facilitate treatment or disposal.

Some LLW and mixed wastes must be stored for longer periods in anticipation of better treatment processes or while awaiting the availability of treatment facilities. In other cases, radioactive wastes may be placed in long-term storage to allow the level of radioactivity in the waste to decay. Many DOE sites and installations store waste temporarily until disposal sites are available and can accept the waste. Departmental guidance/Orders normally limit storage to one year to minimize buildup of a legacy problem.

Low-level waste must be stored until it can be treated and/or disposed.

LLW is usually disposed at selected disposal facilities in pits, trenches or shafts. Liquid wastes are treated to separate the radioactive component or solidified so that no free liquid remains prior to disposal.

Some liquid, low-level waste is mixed with fly ash or cement and poured into metal containers. Once the waste has hardened, the drums are placed in concrete vaults where they await authorized disposal.

Hazardous waste is generally accumulated for a short time on site and subsequently sent to permitted commercial facilities for treatment and disposal.

Waste with no disposal path is packaged and placed in permitted storage awaiting the development of appropriate treatment. On occasion, waste may be stored in permitted areas to accumulate sufficient quantities to facilitate treatment.

The Land Disposal Restrictions (LDR) portion of RCRA is intended to greatly limit the land disposal of hazardous waste.

DOE has established a national TRU program to strategically plan the characterization, transport and disposal of TRU waste in accordance with regulatory requirements.

DOE temporarily stores most TRU waste in a method that allows for easy retrieval. To protect the groundwater under storage areas, the waste is placed in containers and stacked on concrete pads. These containers are then enclosed in a protective vinyl cover and the area is backfilled with soil providing stable storage. The containers can be easily retrieved for future processing and disposal.

DOE has built the Waste Isolation Pilot Plant (WIPP) to dispose TRU waste including mixed TRU waste. A brief overview of WIPP follows.

The WIPP is a geologic repository licensed to safely and permanently dispose of TRU radioactive waste left from the research and production of nuclear weapons. WIPP began operations on March 26, 1999, after more than 20 years of scientific study, public input, and regulatory review.

The WIPP is located in the remote Chihuahuan Desert of southeastern New Mexico, about 80 kilometers (50 miles) from Carlsbad, New Mexico. The repository consists of disposal rooms mined 655 meters (2,150 feet) underground in a 600 meter-thick (2,000 feet) salt formation that has been stable for more than 200 million years. The TRU waste currently stored at 23 locations nationwide will be shipped to and disposed of at WIPP over the next 35 years.

DOE stores its high-level waste (primarily liquid wastes resulting from nuclear fuel reprocessing) in tanks at the Idaho National Laboratory, Idaho; Savannah River, South Carolina; and Hanford, Washington sites. At the Hanford Site, some of the original single-shell tanks that have begun to leak have been replaced by double-shell, carbon-steel tanks. These range in volume from 500,000 to approximately one million gallons each. The double-wall is actually a tank within a tank.

Highly sensitive monitoring equipment is installed in the space between the tank walls to detect any leaks that might occur.

At the Savannah River Site, high-level liquid waste is being removed from the tanks and converted (vitrified) to a solid-waste form suitable for permanent disposal. DOE reduces the volume of high-level waste that it vitrifies by pre-treating the stored high-level waste to separate many of the non-radioactive substances from the radioactive ones. The remaining less radioactive waste will be solidified for disposal. When DOE solidifies high-level waste into glass logs through vitrification, granular calcine, or concrete-like salt stone, the waste still needs to be stored awaiting final disposal.

DOE plans to eventually ship and permanently store high level waste at the Yucca Mountain Project located in Nevada.

The high-level waste will be stored about 1000 feet below the ground in a manner to minimize degradation of waste packages. DOE has performed detailed analysis to determine the safety of permanent storage of HLW at Yucca Mountain.

A large portion of DOE's waste inventory consists of waste that contains radioactive and chemically hazardous components. Mixed wastes are required to be treated, stored, and disposed in compliance with all regulatory requirements applicable to both their radioactive component and their chemically hazardous component.

LDR treatment standards apply to mixed wastes, but compliance is not always appropriate or possible because of the radioactive characteristics of mixed wastes.

In compliance with the Federal Facility Compliance Act of 1992, DOE has worked with state and federal regulators to develop site-specific treatment plans for achieving compliance with LDR treatment standards for low-level mixed wastes (discussed in more detail in Competency 10).

DOE sites are storing some low-level mixed wastes in accordance with site-specific plans pending development of appropriate treatment technologies.

DOE also has worked with EPA to obtain variances from the federal LDR treatment standards for specific mixed wastes, such as batteries that contain hazardous metals.

Disposal facilities for mixed wastes are limited. DOE operates mixed waste disposal facilities at the Hanford Site and the Nevada Test Site.

Until a new lined, combined-use facility is operational at the Hanford Site (projected for 2007), receipt of mixed LLW for disposal from off site generators is limited to 5,000 cubic meters.

Currently, the Nevada Test Site (NTS) RCRA Permit restricts disposal of mixed LLW to only that which is generated at the NTS facility. A permit modification has been requested.

DOE sends mixed LLW from many of its sites to the only commercial disposal facility permitted to receive it, which is located in Utah.

References: 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"
10 CFR 261, "Identification and Listing of Hazardous Waste"
Atomic Energy Act, 1954
DOE M 435.1, *Radioactive Waste Management Manual*
DOE O 435.1, *Radioactive Waste Management*
Federal Facility Compliance Act of 1992
Low-Level Radioactive Waste Policy Amendments Act of 1985
Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act (LWA), Public Law 102-579

Yucca Mountain Site Suitability Evaluation, OE/RW-0549, February 2002

8. Personnel shall demonstrate a familiarity level knowledge of DOE Orders and standards, regulations and laws related to environmental protection, pollution prevention, environmental restoration, and waste management issues.

a. Discuss the purpose of the following environmental laws as they apply to the Department and the contractors that operate its facilities:
- **National Environmental Policy Act (NEPA)**
- **Resource Conservation and Recovery Act (RCRA)**
- **Comprehensive Environmental Response, Compensation, and Liability Act-Superfund Act (CERCLA)**

National Environmental Policy Act (NEPA)

The Act establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment; and it provides a process for implementing these goals within the federal agencies. Section 102 requires federal agencies to incorporate environmental considerations in their planning and decision-making through a systematic interdisciplinary approach. Specifically, all federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. These statements are commonly referred to as environmental impact statements (EISs).

Environmental assessments (EAs) are another type of NEPA document that provide less detailed analysis that EISs. An EA is prepared to determine if an EIS is required, or if a finding of no significant impact can be issued. A third type of NEPA review, a Categorical Exclusion, may be appropriate when a proposed action fits within a typical class of actions that an agency has determined do not individually or cumulatively have a significant effect on the human environment.

National Pollutant Discharge Elimination System (NPDES)

The NPDES program is an element of the Clean Water Act (CWA) designed to impose effluent limitations on, or otherwise to prevent, discharges of “pollutants” into any “waters of the United States” from any “point source.” The NPDES is a permit program
- requiring dischargers to disclose the volume and nature of their discharges;
- authorizing Environmental Protection Agency (EPA) or the states to specify the limitations to be imposed on such discharges;
- imposing on dischargers an obligation to monitor and report as to their compliance or noncompliance with limitations so imposed;
- authorizing EPA or state and citizen enforcement in the event of non-compliance.

Resource Conservation and Recovery Act (RCRA)

RCRA is a regulatory statute designed to provide “cradle to grave” control of hazardous waste by imposing management requirements on generators and transporters of hazardous wastes and upon owners and operators of treatment, storage, and disposal facilities. RCRA applies mainly to active facilities and does not address the serious problem of abandoned and inactive sites. RCRA amended the Solid Waste Disposal Act (SWDA); therefore, the two terms are sometimes used synonymously. Subtitle A of RCRA declares that the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible, and land disposal should be the least favored method for managing hazardous wastes. Additionally, all waste that is generated must be handled to minimize the present and future threat to human health and the environment.

RCRA goals are

- to protect human health and the environment from the hazards posed by waste disposal;
- to conserve energy and natural resources through waste recycling and recovery;
- to reduce or eliminate, as expeditiously as possible, the amount of waste generated, including hazardous waste;
- to ensure that wastes are managed in a manner that is protective of human health and the environment.

Comprehensive Environmental Response, Compensation, and Liability Act - Superfund Act (CERCLA)

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act, usually referred to as CERCLA or Superfund. CERCLA's most basic purposes are to provide funding and enforcement authority for cleaning up the thousands of hazardous waste sites created in the U.S. in the past which are now abandoned and inactive and to respond to hazardous substance spills.

b. Using references, discuss the purpose of the following environmental laws as they apply to the Department and the contractors that operate its facilities:

- **Clean Water Act (CWA), including the National Pollution Discharge Elimination System (NPDES)**
- **Clean Air Act (CAA)**
- **Emergency Planning and Community Right-To-Know Act (EPCRA)**
- **Federal Facility Compliance Act (FFCA)**
- **Pollution Prevention Act of 1990 (PPA)**
- **Safe Drinking Water Act (SDWA)**
- **Superfund Amendment and Reauthorization Act (SARA)**
- **Toxic Substances Control Act (TSCA)**
- **Solid Waste Disposal Act (SWDA)**

Clean Water Act (CWA)

The goals of the CWA are

- to improve surface water quality to fishable and swimmable;
- to eliminate the discharge of pollutants into the navigable waters;
- to prohibit the discharge of toxic pollutants in toxic amounts;
- to provide Federal financial assistance for construction of publicly owned waste treatment works; and
- to expeditiously develop and implement programs to control non-point sources of pollution.

To accomplish its goals, the CWA establishes requirements including

- that all point sources meet technology-based effluent limitations established by EPA;

- that each state adopt water quality standards for each water body within its boundaries, subject to EPA approval;
- that facilities discharging pollutants into navigable waters from point sources obtain permits from EPA or an approved state (NPDES permitting program).

Clean Air Act (CAA)

The purposes of the CAA are

- to protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population;
- to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution;
- to provide technical and financial assistance to state and local governments in connection with the development and execution of their air pollution prevention and control programs;
- to encourage and assist the development and operation of regional air pollution prevention and control programs.

Emergency Planning and Community Right-To-Know Act (EPCRA)

EPCRA was enacted as a freestanding provision of the Superfund Amendments and Reauthorization Act. EPCRA requires state and local governments to develop emergency plans for responding to unanticipated environmental releases of a number of acutely toxic materials known as extremely hazardous substances. Additionally, the statute has established an information collection and transfer program. Businesses covered by EPCRA are required to notify state and local emergency planning entities of the presence and quantities in inventory of such substances at their facilities and to notify federal, state, and local authorities of planned and unplanned environmental releases of those substances.

Federal Facility Compliance Act (FFCA)

The Federal Facility Compliance Act of 1992 establishes that federal facilities do not have sovereign immunity from state enforcement of state environmental laws under the solid and hazardous waste provisions of the RCRA. Thus, federal facilities are obligated to pay fines and penalties assessed by states. Additionally, provisions of the Act give EPA broader enforcement authority at federal facilities. The Act created a new mixed-waste provision requiring reports on the national inventory of all mixed-waste on a state-by-state basis and on the nation's inventory on mixed-waste treatment capacities and technologies. As a result of these reporting requirements DOE sites have developed, obtained approval from the state, and committed to compliance with a site treatment plan (STP). The STP addresses technologies and capacities to treat mixed waste to meet the land disposal requirements.

The FFCA clarifies how certain RCRA requirements and sanctions apply to the management of hazardous and mixed wastes at Federal facilities. Before the FFCA was passed, Federal facilities were required to comply with RCRA regulations, but they had sovereign immunity from fines and penalties for certain violations.

The FFCA contains the following provisions affecting DOE facilities:

- Waiver of sovereign immunity from enforcement of solid and hazardous waste requirements. This provision obligates Federal facilities to pay fines and penalties

assessed by states or EPA for noncompliance with solid and hazardous waste requirements.
- Limitation on the civil liability of a Federal employee for noncompliance with solid and hazardous waste requirements committed while the employee is acting within the scope of his/her official duties.

DOE had to
- prepare and submit a national inventory report identifying the volume, characteristics, treatment capacity, and available treatment technologies for DOE's mixed wastes; and
- prepare and submit STPs that include the approach and schedule for developing the needed treatment capacity and treating mixed wastes at each DOE site where mixed wastes were generated or stored.

Today, many DOE facilities are still operating under the provisions of an STP while they await either the development of a treatment technology that is appropriate for their mixed wastes or the availability of mixed waste treatment and disposal capacity.

Pollution Prevention Act of 1990 (PPA)

The PPA states, "the Congress hereby declares it to be the national policy of the United States that pollution should be prevented or reduced at the source whenever feasible; pollution that cannot be prevented should be recycled in an environmentally safe manner, whenever feasible; and disposal or other release into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner."

Safe Drinking Water Act (SDWA)

The SDWA was enacted to regulate drinking water systems. The act required EPA to set national standards for levels of contaminants in drinking water, and created a program for states to regulate underground injection wells and for the protection of sole source aquifers.

Superfund Amendments and Reauthorization Act (SARA)

The Superfund Amendments and Reauthorization Act of 1986 revised the CERCLA cleanup standards, strengthened the CERCLA settlement and enforcement provisions, and created a larger revenue base for financing and replenishing the Superfund. SARA did not, however, alter CERCLA's fundamental program elements.

Toxic Substances Control Act (TSCA)

The TSCA has two main regulatory features: first, acquisition of sufficient information by EPA to identify and evaluate potential hazards from chemical substances; second, regulation of the production, use, distribution, and disposal of such substances where necessary. The main provisions of the Act include pre-manufacture notification, inventory list, reporting requirements, and testing requirements. Additionally, TSCA specifically regulates polychlorinated biphenyl, chlorofluorocarbons, and asbestos.

Solid Waste Disposal Act (SWDA)

In 1965 the Solid Waste Disposal Act (Public Law [Pub. L.] 89-72) was enacted to improve solid waste disposal methods. It was amended in 1970 by the Resource Recovery Act (Pub.

L. 91-512), which provided the Environmental Protection Agency (EPA) with funding for resource recovery programs. However, that Act had little impact on the management and ultimate disposal of hazardous waste. In 1976 Congress enacted the Resource Conservation and Recovery Act (RCRA, Pub. L. 94-580). RCRA established a system for managing non-hazardous and hazardous solid wastes in an environmentally sound manner. Specifically, it provides for the management of hazardous wastes from the point of origin to the point of final disposal (i.e., "cradle to grave"). RCRA also promotes resource recovery and waste minimization.

c. Using the following documents as references, discuss their purpose and general requirements:

- **DOE O 450.1, Admin. Chg. 1, Environmental Protection Program**
- **DOE O 451.1 B, Chg. 1 (formerly DOE Order 5440.1), National Environmental Policy Act Compliance Program**
- **DOE O 435.1, Chg. 1, Radioactive Waste Management**
- **DOE Order 5400.5, Chg. 2, Radiation Protection of the Public and the Environment**

DOE O 450.1, Environmental Protection Program

Objectives

To implement sound stewardship practices that are protective of the air, water, land, and other natural and cultural resources impacted by DOE operations and by which DOE cost effectively meets or exceeds compliance with applicable environmental; public health; and resource protection laws, regulations**,** and DOE requirements.

General Requirements

All DOE elements must ensure that site integrated safety management systems (ISMSs) include an environmental management system (EMS) that does the following:

- Provides for the systematic planning, integrated execution, and evaluation of programs for
    - Public health and environmental protection
    - Pollution prevention and
    - Compliance with applicable environmental protection requirements
- Includes policies, procedures, and training to identify activities with significant environmental impacts, to manage, control, and mitigate the impacts of these activities, and to assess performance and implement corrective actions where needed
- Includes measurable environmental goals, objectives, and targets that are reviewed annually and updated when appropriate

Integration of an EMS into ISMS. As part of integrating EMSs into site ISMSs, DOE elements must do the following:

- Consider the following for inclusion as applicable:
    - Conformity of DOE proposed actions with State Implementation Plans to attain and maintain national ambient air quality standards
    - Implementation of a watershed approach for surface water protection
    - Implementation of a site-wide approach for groundwater protection
    - Protection of other natural resources including biota

- Protection of site resources from wildland and operational fires
- Protection of cultural resources

- Promote the long-term stewardship of a site's natural and cultural resources throughout its operational, closure, and post-closure life cycle.
- Reduce or eliminate the generation of waste, the release of pollutants to the environment, and the use of Class I ozone-depleting substances through source reduction including segregation and substitution, re-use, recycling, and sustainable development, and by procuring environmentally preferable products and services, pursuant to the DOE P2 and Sustainable Environmental Stewardship Goals.
- Ensure the early identification of, and appropriate response to, potential adverse environmental impacts associated with DOE operations, including, as appropriate, preoperational characterization and assessment, and effluent and surveillance monitoring.

DOE O 451.1B, National Environmental Policy Act Compliance Program

The objective of this order is to establish DOE internal requirements and responsibilities for implementing the National Environmental Policy Act (NEPA) of 1969, the Council on Environmental Quality Regulations Implementing the Procedural Provisions of the NEPA (40 CFR parts 1500-1508), and the DOE NEPA Implementing Procedures (10 CFR 1021). The goal of establishing the requirements and responsibilities is to ensure efficient and effective implementation of DOE's NEPA responsibilities through teamwork. A key responsibility for all participants is to control the cost and time for the NEPA process while maintaining its quality.

DOE O 435.1, Radioactive Waste Management

The purpose of this order is to establish policies, guidelines, and minimum requirements by which DOE manages its radioactive and mixed waste and contaminated facilities.

DOE Order 5400.5, Radiation Protection of the Public and the Environment

Purpose

The purpose of this order is to establish standards and requirements for operations of the DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

General Requirements

Chapter II includes the requirements for radiation protection for the public and the environment. Chapter III contains the derived concentration guides for air and water and chapter IV discusses residual radioactive material.

d. Using DOE O 450.1 as a reference, discuss the concept of an Environmental Management System.

The objective of DOE O 450.1 must be accomplished by implementing EMSs at DOE sites. An EMS is a continuing cycle of planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. These EMSs must be part of ISMSs established pursuant to DOE P 450.4, *Safety Management System Policy*, dated 10-15-96.

e. Using DOE Order 5400.5 as a reference, discuss the concept of maintaining doses to the public and the environment as far below dose limits and constraints as is reasonably achievable (i.e., ALARA).

THE ALARA PROCESS–Field Elements shall develop a program and shall require contractors to implement the ALARA Process for all DOE activities and facilities that cause public doses.

Considerations–ALARA requires judgment with respect to what is reasonably achievable. Factors that relate to societal, technological, economic, and other public policy considerations shall be evaluated to the extent practicable in making such judgments. Factors to be considered, at a minimum, shall include the following:

- The maximum dose to members of the public
- The collective dose to the population
- Alternative processes, such as alternative treatments of discharge streams, operating methods, or controls
- Doses for each
- Costs for each
- Examination of process alternative; of the technological alternatives; the changes in-cost among alternatives
- Changes in societal impact associated with process alternatives, e.g., differential doses from various pathways

Evaluations–A quantitative cost-benefit analysis (e.g., optimization) could be performed, given the results of the considerations noted above. However, the parameters needed to evaluate the cost-benefit analyses are difficult to quantify, and evaluations themselves can be expensive. Furthermore, the evaluations include many additional assumptions, judgments, and limitations that are often difficult to reflect as uncertainties in the analyses. Therefore, except for meeting requirements of the National Environmental Policy Act, qualitative analyses are acceptable, in most instances, for ALARA judgments, especially where potential doses are well below the dose limit. The bases for such judgments should be documented. More detailed analyses should be considered if the decisions might result in doses that approach the limit.

References: DOE O 435.1, *Radioactive Waste Management*
DOE O 450.1, Chg 1, *Environmental Protection Program*
DOE O 451.1B, *National Environmental Policy Act Compliance Program*
DOE Order 5400.5, *Radiation Protection of the Public and the Environment*

9. Personnel shall demonstrate a familiarity level knowledge of the purpose and content of 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response.

a. Using 29 CFR 1910.120 as a reference, discuss its purpose as it applies to the Department and the contractors that operate its facilities with respect to the following:

- **Cleanup operations**
- **Corrective actions**
- **Voluntary clean-up operations**
- **Operations involving hazardous wastes**

- **Emergency response operations**

Introduction

29 CFR 1910.120 is an Occupational Safety and Health Administration (OSHA) standard for hazardous waste operations and emergency response. DOE contractors are required by DOE O 440.1A to meet 19 CFR 1910, including 1910.120.

This regulation applies to operations involving hazardous waste and therefore applies to many of the operations at DOE sites. It also provides requirements for emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard and again, therefore applies to DOE sites.

Cleanup Operations (voluntary and mandated), Corrective Actions and Operations involving Hazardous Waste

29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," applies to the following:

- DOE contractors involved in cleanup operations
- DOE contractors operating treatment, storage, and disposal facilities
- Support contractors completing RCRA corrective actions
- DOE contractor involved in voluntary cleanup operations

1910.120 requires that employers shall develop and implement a written safety and health program for their employees involved in hazardous waste operations. The program shall be designed to identify, evaluate, and control safety and health hazards, and provide for emergency response for hazardous waste operations.

The written safety and health program shall incorporate the following:

- Organization structure
- Comprehensive work plan
- Training of employees
- Medical Surveillance of employees

Organization Structure

The organizational structure part of the program shall establish the specific chain of command and specify the overall responsibilities of supervisors and employees.

Comprehensive Work plan

The comprehensive work plan part of the program shall address the tasks and objectives of the site operations and the logistics and resources required to reach those tasks and objectives.

Training

All employees working on site (such as but not limited to equipment operators, general laborers and others) exposed to hazardous substances, health hazards, or safety hazards and their supervisors and management responsible for the site shall receive training meeting the requirements of this paragraph before they are permitted to engage in hazardous waste operations that could expose them to hazardous substances, safety, or health hazards.

Medical Surveillance

The medical surveillance program shall be instituted by the employer for employees

- who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year;
- who wear a respirator for 30 days or more a year;
- who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operations;
- who are members of hazardous materials (HAZMAT) teams.

29 CFR 1910.120 provides some specific requirements for: monitoring of atmospheric condition, engineering controls, and handling drums and containers.

Monitoring of atmosphere conditions

Monitoring shall be performed where there may be a question of employee exposure to hazardous concentrations of hazardous substances in order to assure proper selection of engineering controls, work practices and personal protective equipment so that employees are not exposed to levels which exceed permissible exposure limits, or published exposure levels if there are no permissible exposure limits, for hazardous substances.

Monitoring shall be conducted during initial entry to a hazardous waste site.

Engineering controls, work practices, and personal protective equipment

Engineering controls, work practices, personal protective equipment, or a combination of these shall be implemented to protect employees from exposure to hazardous substances and safety and health hazards.

Handling drums and containers

Drums and containers used during the clean-up shall meet the appropriate Department of Transportation, OSHA, and EPA regulations for the wastes that they contain.

When practical, drums and containers shall be inspected and their integrity shall be assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions (i.e., buried beneath the earth, stacked behind other drums, stacked several tiers high in a pile, etc.) shall be moved to an accessible location and inspected prior to further handling.

Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled.

Emergency Response Operations

Emergency response or responding to emergencies means a response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel are not considered to be emergency responses within the scope of this standard. Responses to releases of hazardous substances where there is no potential safety or health hazard (i.e., fire, explosion, or chemical exposure) are not considered to be emergency responses.

An emergency response plan shall be developed and implemented to handle anticipated emergencies prior to the commencement of hazardous waste operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, OSHA personnel and other governmental agencies with relevant responsibilities.

Elements of an emergency response plan**.** The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following:

- Pre-emergency planning
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination procedures which are not covered by the site safety and health plan
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- PPE and emergency equipment

b. Using 29 CFR 1910.120 as a reference, discuss the role of the Department in the identification, assessment, and reaction to potential risks posed by hazardous wastes that exist at Department sites.

All suspected conditions that may pose inhalation or skin absorption hazards that are immediately dangerous to life or health (IDLH), or other conditions that may cause death or serious harm, shall be identified during a preliminary survey and valuated during a detailed survey. Examples of such hazards include, but are not limited to, confined space entry, potentially explosive or flammable situations, visible vapor clouds, or areas where biological indicators such as dead animals or vegetation are located.

The following monitoring shall be conducted during initial site entry when the site evaluation produces information that shows the potential for ionizing radiation or IDLH conditions, or when the site information is not sufficient reasonably to eliminate these possible conditions:

- Monitoring with direct-reading instruments for hazardous levels of ionizing radiation
- Monitoring the air with appropriate direct-reading test equipment (i.e., combustible gas meters, detector tubes) for IDLH and other conditions that may cause death or serious harm (combustible or explosive atmospheres, oxygen deficiency, toxic substances)
- Visually observing for signs of actual or potential IDLH or other dangerous conditions

An ongoing air-monitoring program shall be implemented after site characterization has determined the site is safe for the start-up of operations.

Once the presence and concentrations of specific hazardous substances and health hazards have been established, the risks associated with these substances shall be identified. Employees who will be working on the site shall be informed of any risks that have been identified.

c. Describe the linkage between 10 CFR 851, Worker Safety and Health Program, and 29 CFR 1910.120.

10 CFR 851.23(a) requires that contractors comply with 29 CFR Part 1910, "Occupational Safety and Health Standards," excluding 29 CFR 1910.1096, "Ionizing Radiation."

References: 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response"
10 CFR 851, "Worker Safety and Health Program"

10. Personnel shall demonstrate a familiarity level knowledge of potential personal and organizational liability associated with environmental laws.

a. Using NEPA as a reference, discuss the Department's responsibilities associated with NEPA and the potential consequences of noncompliance with NEPA.

Federal Agency Liability

EPA has explicit authority to assess fines at federal facilities violating environmental statutes. EPA's federal facilities civil enforcement program helps protect public health and the environment by assuring that federal facilities comply with federal environmental laws.

EPA also enforces environmental cleanup requirements at federal facilities. Cleanup enforcement authority is derived from several statutes: the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), the Resource Conservation and Recovery Act (RCRA), including the Underground Storage Act program, and the Oil Pollution Act, a part of the Clean Water Act (CWA). These statutes, as well as Presidential Executive Orders, require federal facilities to clean up environmental contamination at their facilities.

EPA's criminal enforcement program uses stringent sanctions, including jail sentences, to promote deterrence and help ensure compliance in order to protect human health and the environment. Criminal enforcement is often used against the most serious environmental violations as well as those which involve egregious negligence or conduct involving intentional, willful or knowing disregard of the law.

b. Using RCRA as a reference, discuss the Department's responsibilities associated with RCRA and the potential consequences of noncompliance with RCRA.

The Resource Conservation and Recovery Act (RCRA) has several cleanup enforcement authorities available to compel clean up at RCRA facilities or at places that perhaps should be regulated under RCRA.

States authorized to implement the RCRA Corrective Action program have similar authorities to the federal authorities described below.

Cleanup enforcement under RCRA generally means that EPA, or the authorized state, takes legal action to get cleanup going. The legal action may be one of the following:

- Administrative – EPA has independent authorities to enter into "agreements" and to "order" (require) clean-up action; or
- Judicial – EPA works with the Department of Justice to secure a court approved agreement or order for action.

The federal RCRA cleanup enforcement authorities include the following:

- RCRA Section 3008(h) – EPA can use this authority at facilities that manage RCRA hazardous waste under "interim status" (i.e., facilities that have not yet received RCRA permits), and at some facilities that had or should have had interim status.
- RCRA Section 7003 – EPA uses this authority to address situations that may present an imminent and substantial endangerment.
- RCRA Section 3013 – EPA uses this authority to require an investigation to determine how significant a threat is.
- RCRA Section 3007 – allows EPA to request information regarding hazardous waste practices and events at a facility, and to gain access to a facility to collect waste samples.
- RCRA Section 3008(a) – EPA uses its general RCRA enforcement authority to compel compliance with cleanup responsibilities required in a facility's Subtitle C permit.

References: U.S. Environmental Protection Agency, *RCRA Cleanup Enforcement Authorities*
U.S. Environmental Protection Agency, *Federal Facilities Enforcement and Criminal Enforcement*

11. Personnel shall demonstrate a familiarity level knowledge of the Department's philosophy and approach to implementing Integrated Safety Management (ISM).

a. Explain the objective of ISM.

The objective of ISM is to incorporate safety into management and work practices at all levels, addressing all types of work and all types of hazards to ensure safety for the workers, the public, and the environment. To achieve this objective, DOE has established guiding principles and core safety management functions. The objectives, principles, and functions are set forth in the DOE policies and DEAR clauses and are discussed in detail in DOE G 450.4.1B, *Integrated Safety Management System Guide*. An effective ISMS must address these principles and functions while considering the following:

- the planning and performance of all types of potentially hazardous work, including but not limited to the following: construction, operations, maintenance and decommissioning, as well as design, conceptual studies, environmental analyses, safety analyses, hazard reduction analyses, pollution prevention/waste minimization and risk analyses;
- all types of hazards, including chemical, occupational, environmental, nuclear, electrical, transportation, etc.; and
- the identification, analysis, and control of hazards, and the use of feedback for continuous improvement in defining, planning, and performing work.

b. Describe how the seven guiding principles in the ISM policy are used to implement an integrated safety management philosophy.

The seven guiding principles are

- line management responsibility for safety
- clear roles and responsibilities
- competence commensurate with responsibilities
- balanced priorities
- identification of safety standards
- tailor hazard controls to work
- operations authorization

Guiding Principles 1-3

- Line Management Responsibility for Safety
- Clear Roles and Responsibilities
- Competence Commensurate with Responsibilities

The first three guiding principles relate to responsibilities intrinsic in all five core functions.

These interrelated guiding principles help ensure the management structure has personnel who focus on safe accomplishment of mission, understand their assignments, and can carry out the core safety management functions correctly and efficiently.

Guiding Principle 4: Balanced Priority

Protecting the public, workers, and the environment is a top priority whenever the Department plans and performs work. Critical to this objective is providing adequate resources and ensuring that those resources are effectively allocated. Each organizational level (i.e., DOE Headquarters, DOE field element, and contractor) should, therefore, establish a method for ensuring a proper balance among competing priorities of the organization (e.g., budget, schedule, safety, quality).

Guiding Principle 5: Identification of Safety Standards

The terms and conditions that define DOE safety expectations for its contractors are set forth as contract requirements. DEAR 970.5204-2 requires the contractor to comply with the requirements of applicable Federal, State, and local laws and regulations (including DOE Regulations) in developing and implementing controls, unless the appropriate regulatory agency has granted relief in writing.

DOE has identified safety requirements in Rules and DOE Orders and has developed a wide variety of associated Technical Standards, Guides, and Manuals; in addition, DOE encourages the use of national consensus technical standards.

In addition to complying with the requirements of applicable Federal, State, and local laws and regulations (including DOE Regulations) in developing and implementing controls, as required by DEAR 970.5204-2(a) (List A), the contractor must comply with the requirements of applicable DOE directives appended to the contract [List B at DEAR 970.5204-2(b)].

c. Describe the five core safety management functions in the ISM policy and discuss how they provide the necessary structure for work activities.

The five core safety management functions are as follows:

- Define scope of work
- Analyze hazards
- Develop/implement hazard controls
- Perform work
- Perform feedback and improvement

Core Function 1, Define Scope of Work

DOE and the contractor identify and prioritize work and allocate resources. The contractor's role in this core function is generally to translate broad missions into specific work packages. DOE provides performance expectations by strategic plans, goals, and objectives, and through program execution guidance.

A well-defined scope of work is critical to the success of an ISMS because it

- sets the stage for the scope and depth of hazards identification/analysis;
- is the foundation for the budget formulation/allocation process;
- is the primary factor in establishing expectations and accountability.

A fundamental objective of this core function is to identify the scope, schedule, and costs of activities necessary to achieve DOE missions and expectations in a safe and environmentally sound manner.

Core Function 2, Analyze Hazards

Section 9.3.1 of DOE P 411.1, *Safety Management Functions, Responsibilities, and Authorities (FRAM)*, requires that the field element manager ensure that the contractor's analysis covers the hazards associated with the work and is sufficient for selecting safety standards.

Section 9.3.1 also requires that the Office of Environment, Safety, and Health (EH) monitor and provide technical support on hazard identification and analysis activities as requested or directed by the Cognizant Secretarial Officer (CSO) to ensure that the standards are sufficient to facilitate selection of the appropriate safety standards. EH is also required to provide guidance for and interpretation of requirements for all DOE elements on hazard analyses.

Core Function 3, Develop/Implement Hazard Controls

The terms and conditions that define DOE safety expectations for its contractors are set forth as contract requirements. Department of Energy Acquisition Regulations (DEAR) 970.5204-2 requires the contractor to comply with the requirements of applicable federal, state, and local laws and regulations (including DOE regulations) in developing and implementing controls, unless the appropriate regulatory agency has granted relief in writing.

DOE has identified safety requirements in rules and DOE Orders and has developed a wide variety of associated technical standards, guides, and manuals. Additionally, DOE encourages the use of national consensus technical standards. In addition to complying with the requirements of applicable federal, state, and local laws and regulations (including DOE

Regulations) in developing and implementing controls, as required by DEAR 970.5204-2(a) (list A), the contractor must comply with the requirements of applicable DOE directives appended to the contract. Environment, safety, and health (ES&H) requirements appropriate for work conducted by a contractor may be determined using a DOE-approved process to evaluate the work and the associated hazards and to identify an appropriately tailored set of standards, practices, and controls. When such a process is used, the set of tailored ES&H requirements must be reviewed for adequacy and approved by the contracting officer.

Core Function 4, Perform Work

DOE and the contractor identify and implement safety controls before starting work. Once work begins, it is performed according to those safety controls. Accordingly, each contractor's ISMS should have a process to confirm adequate preparation, including adequacy of controls before authorizing work to begin at the facility, project, or activity level. DEAR 970.5223-1(b)(7) requires that DOE and the contractor establish and agree on the conditions and requirements to be satisfied to initiate and conduct operations. These conditions and requirements are included in the contract and are therefore binding on the contractor. The formality and rigor of the review process and the extent of documentation and level of authority for agreement should be based on the hazard and complexity of the work being performed. The process should ensure programs addressing all applicable functional areas are implemented adequately to support safe performance of the work.

Core Function 5, Perform Feedback and Improvement

Feedback and improvement complete the ISMS loop by connecting practical experiences of work conducted to planning for future work. The feedback and improvement function is intended to identify and correct processes or deviations that lead to unsafe or undesired work outcomes, confirm that the desired work outcomes were obtained safely, and provide managers and workers with information to improve the quality and safety of subsequent similar work.

Mechanisms that support these goals include worker and management observations, pre- and post-work review meetings, quality and safety issue resolution processes, issue tracking systems, performance indicators, lessons learned, internal and external assessments, operational and strategic planning, and a variety of other such activities. It is necessary for each of these mechanisms to use information from the others to derive maximum benefit from the feedback and improvement safety management function.

d. Identify and discuss existing Department manuals, guides, standards and other documents and practices supporting implementation of ISM, including the following:

- **DOE M 450.4-1, Integrated Safety Management System Manual**
- **DOE G 450.4-1B, Integrated Safety Management System Guides**
- **Standards/Requirements Identification Documents (S/RIDs) and Work Smart Standards**
- **Contract reform and performance-based contracting**

DOE M 450.4-1, Integrated Safety Management System Manual

The purpose of this manual is to clearly identify and institutionalize DOE requirements and responsibilities regarding development and implementation of Integrated Safety Management

(ISM) systems within DOE. This manual provides requirements and guidance for DOE and contractors to ensure development and implementation of an effective ISM system that is periodically reviewed and continuously improved.

DOE G 450.4-1B, Integrated Safety Management System Guides

This guide has two purposes. One purpose is to assist DOE contractors in developing, describing, and implementing an ISMS in compliance with DOE P 450.4, *Safety Management System Policy (the SMS Policy);* DOE P 450.5, *Line Environment, Safety and Health Oversight;* DOE P 450.6, *Secretarial Policy Statement Environment, Safety And Health;* DOE P 411.1, *Safety management functions, responsibilities, and authorities (FRAM);* and the following provisions of the Department of Energy Acquisition Regulation (DEAR):

- 48 CFR 970.5223-1, which requires integration of environment, safety, and health into work planning and execution
- 48 CFR 970.5204-2, which deals with laws, regulations, and DOE directives
- 48 CFR 970.1100-1, which requires performance-based contracting

Attachments 1 through 5 to volume 1 contain the full text of the policies and the relevant ISMS sections of the DEAR.

A second purpose of this guide is to assist DOE line managers and contracting officers who

- provide ISMS guidance and requirements;
- review and approve ISMS products;
- verify implementation of the ISMS;
- perform various integrating activities (e.g., planning, budgeting, review, approval, and oversight) that complement or are required for the ISMS.

DOE responsibilities for these activities are described in the three ISMS-related DEAR clauses listed above, DOE M 411.1-1B, *Manual of Safety Management Functions, Responsibilities, And Authorities (the FRAM),* and the lower-tier Functions, Responsibilities, and Authorities documents.

S/RIDS

The concept of S/RIDs was developed by DOE's Offices of Defense Programs (DP) and Environmental Management (EM) in response to Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 90-2.

This recommendation, which was accepted by DOE, was that DOE should develop mechanisms for identifying which standards are applicable to the work, determining whether those standards are fully implemented, and determining whether the standards are appropriate and adequate to ensure protection of workers, the public, and the environment.

The original concept of S/RIDs as espoused by DP was a document that included all applicable Order requirements for which an exemption had not been granted, plus additional laws, regulations, and other standards necessary to ensure adequacy. EM's original concept was somewhat different. They believed from the beginning that many applicable Order requirements added little safety value for the types of work they did. In their concept, S/RIDs would result in selection of only those requirements that were important to a sound ES&H program.

By the time the S/RID Development and Approval Instruction was issued in September 1994, the S/RID concept had evolved considerably. An S/RID was defined as containing "the standards/requirements that are necessary and sufficient to provide an adequate level of protection of workers, the public, and the environment."

The determination of selected standards was to be tailored to the work to be performed. "Judgments related to inclusion of requirements in S/RID will be based on the hazards present at the site, facility, or activity." There was no longer any requirement to include all applicable DOE Order requirements. Justification for standards/requirements not chosen for inclusion was not required, although the instruction recommended that records of the rationale for not including Order requirements should be maintained until DP, EH, and EM could agree on a process for permitting them to be dropped without formal exemptions.

It is important to note that many of the S/RIDs prepared in the DOE complex were prepared before the final instruction was issued and followed earlier ground rules. In many cases, the completed S/RIDs included excessive requirements. Also, since the process was not specified in the instruction, some of the groups preparing S/RIDs used a formal and rigorous process, while others did not.

Similarities between S/RIDs and Work Smart Standards (WSS) Sets

S/RIDs and WSS sets are intended to achieve the same goals: to arrive at a mutually agreed upon set of ES&H and related standards that a contractor is contractually obligated to implement. The two concepts are really a single concept that represents maturating ideas and increased experience in standards management.

They include standards that are necessary and sufficient to protect the environment and the health and safety of workers and the public. They address hazards of the work performed.

Differences between S/RIDs and WSS Sets

S/RIDs are limited to activities conducted under DP and EM, while WSS are intended to apply to all departmental ES&H activities. However, Headquarters has stated that the WSS process cannot be applied to emergency management or occurrence reporting.

The S/RID instruction describes an end product, with little information on how to create that product. DOE M 450.3-1, *Documentation for Work Smart Standards Applications: Characteristics and Considerations,* which provides instructions for the development of WSS sets, does not describe the end product in any detail.

Instead, it provides assurance through a defined process that the set of standards is adequate for its intended use and has broad buy-in by the various groups performing, managing, overseeing, or otherwise involved in the work.

A WSS set for a specific scope of work replaces the S/RID for that scope of work. Any exceptions are identified in the WSS approval or in the contract modification incorporating the WSS set into the contract. Also, the WSS program is a refined and improved version of the S/RID program. New sets of standards for contractors developed after April 1996 will be developed using the WSS Closure Process.

Contract Reform and Performance-Based Contracting

In 1997, the Department published a final rule (*Acquisition Regulations: Department of Energy Management and Operating Contracts, 62 FR 34842*) that implemented a number of recommendations principally in areas relating to the acquisition processes of its management and operating contracts. One of these recommendations involved the adoption of performance-based contracting concepts. Since the beginning of its contract reform initiatives, the Department has tested a number of approaches to conform its use of fees to such concepts. A core consideration in the application of performance-based contracting concepts is the development of performance measures that are used to evaluate a contractor's accomplishments on either a subjective or objective basis, or both, and awarding a fee based on that performance.

e. Discuss the purpose, content, and application of DOE P 450.4, Safety Management System Policy.

Safety management systems provide a formal, organized process whereby people plan, perform, assess, and improve the safe conduct of work. The safety management system is institutionalized through DOE Directives and contracts to establish the Department-wide safety management objective, guiding principles, and functions.

The system encompasses all levels of activities and documentation related to safety management throughout the DOE complex. Throughout this policy statement, the term "safety" is used synonymously with ES&H to encompass protection of the public, the workers, and the environment.

The DOE safety management system establishes a hierarchy of components to facilitate the orderly development and implementation of safety management throughout the DOE complex. The safety management system consists of six components: objective, guiding principles, core functions, mechanisms, responsibilities, and implementation.

The objective, guiding principles, and core functions of safety management shall be used consistently in implementing safety management throughout the DOE complex. The mechanisms, responsibilities, and implementation components are established for all work and will vary based on the nature and hazard of the work being performed.

f. Discuss the relationship of DEAR Clause 970.5223-1, Integration of Environment, Safety, and Health into Work Planning and Execution, to the ISM process.

Sections (c) through (i) of this clause establish the foundation for ISMS. The following is an excerpt from the regulation.

The contractor shall manage and perform work according to a documented safety management system. Documentation of the system shall describe how the contractor will: define the scope of work, identify and analyze hazards associated with the work, develop and implement hazard controls, perform work within controls, provide feedback on adequacy of controls and continue to improve safety management.

The system shall describe how the contractor will establish, document, and implement safety performance objectives, performance measures, and commitments in response to DOE program and budget execution guidance while maintaining the integrity of the system. The system shall also describe how the contractor will measure system effectiveness.

The contractor shall comply with, and assist DOE in complying with, ES&H requirements of all applicable laws and regulations, and applicable directives identified in the clause of the contract entitled “Laws, Regulations, and DOE Directives.” The contractor shall cooperate with federal and non-federal agencies having jurisdiction over ES&H matters under the contract. The contractor shall promptly evaluate and resolve any noncompliance with applicable ES&H requirements and the system.

If the contractor fails to provide resolution or if, at any time, the contractor’s acts or failure to act causes substantial harm or an imminent danger to the environment or health and safety of employees or the public, the contracting officer may issue an order stopping work in whole or in part.

Any stop work order issued by a contracting officer under this clause shall be without prejudice to any other legal or contractual rights of the Government. In the event that the contracting officer issues a stop work order, an order authorizing the resumption of the work may be issued at the discretion of the contracting officer. The contractor shall not be entitled to an extension of time or additional fee or damages by reason of, or in connection with, any work stoppage ordered in accordance with this clause.

Regardless of the performer of the work, the contractor is responsible for compliance with the ES&H requirements applicable to the contract. The contractor is responsible for flowing down the ES&H requirements applicable to the contract to subcontracts at any tier to the extent necessary to ensure the contractor’s compliance with the requirements. The contractor shall include a clause substantially the same as this clause in subcontracts involving complex or hazardous work on site at a DOE-owned or DOE-leased facility. Such subcontracts shall provide for the right to stop work under the conditions described in this clause. Depending on the complexity and hazards associated with the work, the contractor may choose not to require the subcontractor to submit a safety management system for the contractor’s review and approval.

g. Describe the requirements in 10 CFR 830 Subpart A and DOE O 414.1C to integrate the ISM system description with the quality assurance program.

DOE O 450.1 5(d) (15) requires DOE elements to ensure that the analytical work supporting environmental monitoring is implemented using

- a consistent system for collecting, assessing, and documenting environmental data of known and documented quality;
- a validated and consistent approach for sampling and analysis of radionuclide samples to ensure laboratory data meet program-specific needs and requirements within the framework of a performance-based approach for analytical laboratory work;
- an integrated sampling approach to avoid duplicative data collection.

The Uniform Federal Policy for Implementing Environmental Quality Systems (UFP-QS) offers an implementation tool for meeting this requirement. The UFP-QS is based on the American National Standards Institute/American Society for Quality Control E-4 (ANSI/ASQC E4, 1994). The Quality System (QS) is a structured and documented management system (to be integrated into the site ISMS/EMS) that provides recommendations to Federal agencies for documenting and implementing a quality system for the management of environmental data collection and use. It ensures that data used to support environmental decisions are of adequate quality and usability for the intended purpose. The overall goal of this consensus system is simple: sound decisions must be based on sound documented data.

The QS is documented, at the organizational level, in a Quality Management Plan (QMP). The QMP details information by which the organization will manage, plan, implement, assess, and continually improve the activities involved in environmental data collection and use3. At the project level the QS is documented in a Uniform Federal Policy for Quality Assurance Project Plan 4.

References: DOE G 450.1-2, *Implementation Guide for Integrating Environmental Management Systems into Integrated Safety Management Systems*
DOE M 450.4-1, *Integrated Safety Management System Manual*
DEAR Clause 970.5223-1, “Integration of Environment, Safety, and Health into Work Planning and Execution”
Department of Energy Acquisition Regulations (DEAR) 970.5204-2
DOE M 450.3-1, *Documentation for Work Smart Standards Applications: Characteristics and Considerations*
Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 90-2
DOE P 450.4, *Safety Management System Policy*
DOE P 411.1, *Safety Management Functions, Responsibilities, and Authorities*
DOE M 450.4-1, *Integrated Safety Management System Manual*
DOE G 450 4.1B, *Integrated Safety Management System Guide for Use with Safety Management System Policies (DOE P 450.4, DOE P 450.5, AND DOE P 450.6); The Functions, Responsibilities, and Authorities Manual; and The Department Of Energy Acquisition Regulation*

12. Personnel shall demonstrate a familiarity level knowledge of 10 CFR 851, Worker Safety and Health Program, and DOE O 440.1B, Worker Protection Program for DOE (including National Nuclear Security Administration) Federal Employees.

a. Discuss the requirements for development and approval of worker safety and health programs.

Preparation and submission of worker safety and health program

Contractors must submit to the appropriate Head of DOE Field Element for approval a written worker safety and health program that provides the methods for implementing the requirements of 10 CFR 851.11.

If a contractor is responsible for more than one covered workplace at a DOE site, the contractor must establish and maintain a single worker safety and health program for the covered workplaces for which the contractor is responsible.

If more than one contractor is responsible for covered workplaces, each contractor must

- establish and maintain a worker safety and health program for the workplaces for which the contractor is responsible;
- coordinate with the other contractors responsible for work at the covered workplaces to ensure that there are clear roles, responsibilities and procedures to ensure the safety and health of workers at multi-contractor workplaces.

The worker safety and health program must describe how the contractor will

- comply with the requirements set forth in subpart C of 10 CFR 851 that are applicable to the covered workplace, including the methods for implementing those requirements;
- integrate the requirements set forth in subpart C of 10 CFR 851 that are applicable to a covered workplace with other related site-specific worker protection activities and with the integrated safety management system.

DOE evaluation and approval

The Head of DOE Field Element must complete a review and provide written approval of the contractor's worker safety and health program, within 90 days of receiving the document. The worker safety and health program and any updates are deemed approved 90 days after submission if they are not specifically approved or rejected by DOE earlier.

No work may be performed at a covered workplace unless an approved worker safety and health program is in place for the workplace.

Contractors must send a copy of the approved program to the Chief Health, Safety and Security Officer.

Contractors must furnish a copy of the approved worker safety and health program, upon written request, to the affected workers or their designated representatives.

Updates

Contractors must

- submit an update of the worker safety and health program to the appropriate Head of DOE Field Element, for review and approval whenever a significant change or addition to the program is made, or a change in contractors occurs;
- submit annually to DOE either an updated worker safety and health program for approval or a letter stating that no changes are necessary in the currently approved worker safety and health program;
- incorporate in the worker safety and health program any changes, conditions, or workplace safety and health standards directed by DOE consistent with the requirements of this part and DEAR 970.5204-2, *Laws, Regulations and DOE Directives* (December, 2000) and associated contract clauses.

Labor Organizations

If a contractor employs or supervises workers who are represented for collective bargaining by a labor organization, the contractor must

- give the labor organization timely notice of the development and implementation of the worker safety and health program and any updates thereto;
- upon timely request, bargain concerning implementation of 10 CFR 851.11, consistent with the Federal labor laws.

b. Describe management responsibilities and worker rights and responsibilities.

Management responsibilities

Contractors are responsible for the safety and health of their workforce and must ensure that contractor management at a covered workplace perform the following:

- Establish written policy, goals, and objectives for the worker safety and health program;
- Use qualified worker safety and health staff (e.g., a certified industrial hygienist, or safety professional) to direct and manage the program;
- Assign worker safety and health program responsibilities, evaluate personnel performance, and hold personnel accountable for worker safety and health performance;
- Provide mechanisms to involve workers and their elected representatives in the development of the worker safety and health program goals, objectives, and performance measures and in the identification and control of hazards in the workplace;
- Provide workers with access to information relevant to the worker safety and health program;
- Establish procedures for workers to report without reprisal job-related fatalities, injuries, illnesses, incidents, and hazards and make recommendations about appropriate ways to control those hazards;
- Provide for prompt response to such reports and recommendations;
- Provide for regular communication with workers about workplace safety and health matters;
- Establish procedures to permit workers to stop work or decline to perform an assigned task because of a reasonable belief that the task poses an imminent risk of death, serious physical harm, or other serious hazard to workers, in circumstances where the workers believe there is insufficient time to utilize normal hazard reporting and abatement procedures; and
- Inform workers of their rights and responsibility by appropriate means, including posting the DOE-designated Worker Protection Poster in the workplace where it is accessible to all workers.

Worker rights and responsibilities

Workers must comply with the requirements of this part, including the worker safety and health program, which are applicable to their own actions and conduct. Workers at a covered workplace have the right, without reprisal, to

- participate in activities described in this section on official time;
- have access to

- DOE safety and health publications;
- the worker safety and health program for the covered workplace;
- the standards, controls, and procedures applicable to the covered workplace;
- the safety and health poster that informs the worker of relevant rights and responsibilities;
- limited information on any recordkeeping log (OSHA Form 300);
- access is subject to Freedom of Information Act requirements and restrictions;
- the DOE Form 5484.3 (the DOE equivalent to OSHA Form 301) that contains the employee's name as the injured or ill worker;

- be notified when monitoring results indicate the worker was overexposed to hazardous materials;
- observe monitoring or measuring of hazardous agents and have the results of their own exposure monitoring;
- have a representative authorized by employees accompany the Director or his authorized personnel during the physical inspection of the workplace for the purpose of aiding the inspection. When no authorized employee representative is available, the Director or his authorized representative must consult, as appropriate, with employees on matters of worker safety and health;
- request and receive results of inspections and accident investigations;
- express concerns related to worker safety and health;
- decline to perform an assigned task because of a reasonable belief that, under the circumstances, the task poses an imminent risk of death or serious physical harm to the worker coupled with a reasonable belief that there is insufficient time to seek effective redress through normal hazard reporting and abatement procedures; and
- stop work when the worker discovers employee exposures to imminently dangerous conditions or other serious hazards; provided that any stop work authority must be exercised in a justifiable and responsible manner in accordance with procedures established in the approved worker safety and health program.

c. Describe hazard identification, assessment, prevention, and abatement.

Hazard Identification

The contractor is required to evaluate operations, procedures, and facilities to identify hazards as discussed in 10 CFR 851.21(a)(5).

Ongoing hazard identification is accomplished most effectively by workers and their supervisors during the course of daily activities, with technical assistance from worker protection professionals and functional area technical experts, as necessary.

Daily workplace evaluations by workers and supervisors include such things as inspections of tools and equipment, ranging from inspection of manual tools and power tools, forklifts, cranes, slings, and warning systems to inspection of respiratory protective equipment and other personal protective equipment prior to and during use. In addition, workplace conditions, housekeeping, utilization of assigned personal protective equipment, and conformance with procedures, work permits, health and safety plans, and other established criteria should be evaluated. Workers and supervisors should consult with worker protection professionals as necessary to address questions regarding regulatory requirements and compliance or where specific technical expertise is needed.

In addition, daily worker and supervisor evaluations should be supplemented by worker protection professional evaluations of the workplace. These routine evaluations should include both informal unscheduled walk-through evaluations conducted during worksite visits and formal, scheduled periodic workplace evaluations.

An initial hazard evaluation should be conducted to identify hazards and establish a baseline for future evaluations. The initial evaluation could consist of a comprehensive "wall-to-wall" evaluation, a compilation of results of evaluations that pre-date the Rule and are still valid, or a combination of both. Regularly scheduled evaluations should be conducted at all workplaces, including permanently housed construction workplaces, using a graded approach to set the frequency. For example, office buildings and other low hazard workplaces may be evaluated every three years; shops, laboratories, and warehouses every two years, and high hazard workplaces annually. Fire safety inspections should be conducted on a frequency agreed to by the fire protection Authority Having Jurisdiction. Evaluations should then be conducted as often as necessary to ensure compliance with the Rule [851.21(c)]. The evaluations are conducted to identify and document existing and potentially hazardous work conditions and practices that do not comply with worker protection requirements or may otherwise pose hazards to the safety or health of workers. Evaluations should be performed by worker protection professionals with the participation of affected employees and supervisors.

An effective approach to accomplishing such an evaluation is to use a team comprised of affected employees and supervisors, as well as the worker protection professionals necessary to evaluate specific workplace hazards. Worker protection professionals required on the team may include

- safety professionals;
- industrial hygienists;
- occupational medical professionals;
- workers and supervisors; and
- other worker protection professionals, as appropriate for the nature of the workplace and the hazards associated with the activities.

Alternatively, the team could include safety and health professionals that are cross-trained in the disciplines applicable to the workplace being evaluated. These cross-trained professionals would consult with functional area experts as needed.

The evaluation team should use worker protection hazard abatement information, information from the employee concerns program, results of baseline and previous inspections, and injury and illness data, among others, as tools for determining their strategy for such evaluations.

Other formal methods for the evaluation of specific types of hazards in the work place are available such as the fire hazards analyses and facility related fire safety assessments found in DOE G 440.1-5 (also referred to as G 420.1/B-0 and DOE G 440.1/E-0), *Implementation Guide for use with DOE O 420.1* and DOE O 440.1, *Fire Safety Program* (under revision as

DOE G 420.1-3). Detailed information on the selection and use of various hazard analysis methodologies and techniques for chemical hazards is available in the American Institute of Chemical Engineers' *Guidelines for Hazard Evaluation Procedures,* second edition, 1992.

Assessment

The Rule requires assessment of worker exposure to chemical, physical, biological, and safety workplace hazards through appropriate monitoring [851.21(a)(1)]. For health hazard exposures, this assessment should entail appropriate

- workplace monitoring (including personal, area, wipe, and bulk sampling; and measuring non-ionizing radiation, noise, vibration, heat and cold extremes, and ergonomic stressors);
- biological monitoring;
- observation; and
- projections of potential exposures based on modeling or product and industry literature searches.

Prevention

An effective hazard abatement program is essential to ensure that workers are protected from exposure to current and future workplace hazards. The focus of this program must be the control of identified workplace hazards. Where immediate control is not possible, the program must ensure the protection of workers while awaiting final abatement of the hazard. For significant hazards, this should include interim compensatory measures (e.g., limiting activities in the area, installing barriers and signs, providing hazard-specific training, and use of fire watches). It must provide an efficient mechanism to ensure that all identified hazards are abated in a timely manner.

Abatement

The rule requires contractors to implement a process to prevent or abate identified and potential hazards.

For hazards identified either in the facility design or during the development of procedures, controls must be incorporated in the appropriate facility design or procedure [851.22(a)(1)].

Hazards that are identified in the design phase of new facilities and facility modifications or during the development or modification of procedures should be eliminated or controlled through design or procedure changes. The controls implemented should be commensurate with the risk level identified in the risk assessment process. For example, hazards that pose a serious threat to employee safety and health should be either eliminated or effectively controlled.

Proposed design or procedure modifications intended to eliminate or control hazards should be reviewed by worker protection professionals to ensure that the change adequately addresses the hazard and does not introduce new workplace hazards. Alternative control measures should be evaluated to determine the reduction of risk provided by each measure and identify the most effective practical control for the hazard.

Where hazards cannot be controlled through design changes, procedural or administrative controls or the use of personal protective equipment should be considered.

Existing Hazards

For existing hazards identified in the workplace, abatement actions, which are prioritized according to risk to the worker, should be promptly implemented and interim protective measures must be implemented pending final abatement of the hazards. Workers should be protected immediately from dangerous safety and health conditions. Hazards must be systematically managed and documented through final abatement or control.

For existing hazards identified in the workplace, contractors must prioritize and implement abatement actions according to the risk to workers [851.22(a)(2)(i)]. The relative level of risk must be assessed for each identified hazard to ensure that hazard abatement efforts and resources are focused first on addressing the most serious workplace hazards. Conversely, low risk hazards may warrant only minimal abatement efforts and resources and if determined to either be, or have become, sufficiently low should be removed from the category of actively managed hazards.

Risk assessment is an essential element of effective risk management. The assignment of risk levels provides a relatively simple and consistent method of expressing the risk associated with worker exposures to identified hazards. Several DOE sites have developed tools for identifying hazards (some of which are automated), analyzing the hazards, and assigning a value to the level of risk of the hazards. These tools are useful for comprehensively reviewing (usually with a complete check list) all possible hazards of an activity, setting priorities for abatement of hazards, and for determining an appropriate level of work control to apply to activities that present the hazard. These tools can be very efficient but users should be careful to truly analyze the identified hazards and not simply "check the boxes."

Although important in prioritization and abatement planning, assigning a risk assessment code or level to a hazard should not be an impediment to quick abatement. If a hazard can be fixed immediately, assigning a risk category is not necessary, although organizations may prefer to assign one for trending purposes.

The determination of the priority assigned to the abatement of a specific hazard should first be based on the risk of injury or illness the hazard presents to the worker; however, other factors may be considered, including

- regulatory compliance;
- resources (budget and personnel);
- complexity of abatement; and
- the organization's mission.

In some cases, it may be appropriate to address lower-level hazards before higher-level hazards if quick abatement is possible and effective interim protection is in place to protect workers from the higher level hazard until final abatement of the high level hazard can be implemented.

For existing hazards identified in the workplace, contractors must implement interim protective measures pending final abatement [851.22(a)(2)(ii)]. In the interval during which an abatement action is being carried out, contractor organizations must protect their employees from the identified hazards. A short-term strategy should be established that provides interim protection to employees. Methods such as administrative controls, work practice modifications, or personal protective equipment may be used to provide this interim protection. These measures must provide employees with protection that is equivalent to the permanent protection provided by compliance with relevant standards in 851.23 and Appendix A to Part 851.

d. Discuss applicable safety and health standards.

Contractors must comply with the following safety and health standards that are applicable to the hazards at their covered workplace:

- 10 CFR 850, “Chronic Beryllium Disease Prevention Program”
- 29 CFR Parts 1904.4 through 1904.11, 1904.29 through 1904.33; 1904.44, and 1904.46, “Recording and Reporting Occupational Injuries and Illnesses”
- 29 CFR 1910, “Occupational Safety and Health Standards,” excluding 29 CFR 1910.1096, “Ionizing Radiation”
- 29 CFR 1915, “Shipyard Employment”
- 29 CFR 1917, “Marine Terminals”
- 29 CFR 1918, “Safety and Health Regulations for Longshoring”
- 29 CFR 1926, “Safety and Health Regulations for Construction”
- 29 CFR 1928, “Occupational Safety and Health Standards for Agriculture
- American Conference of Governmental Industrial Hygienists (ACGIH), “Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,” (2005) when the ACGIH Threshold Limit Values (TLVs) are lower (more protective) than permissible exposure limits in 29 CFR 1910. When the ACGIH TLVs are used as exposure limits, contractors must nonetheless comply with the other provisions of any applicable expanded health standard found in 29 CFR 1910.
- American National Standards Institute (ANSI) Z88.2, *American National Standard for Respiratory Protection* (1992)
- ANSI Z136.1, *Safe Use of Lasers* (2000)
- ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*, sections 4.3 and E4.3 (1999)
- National Fire Protection Association (NFPA) 70, *National Electrical Code* (2005)
- NFPA 70E, *Standard for Electrical Safety in the Workplace* (2004)

e. Discuss the process for obtaining a variance from a safety and health standard.

The following is taken directly from 10 CFR 851.30, Subpart D–Variances:

> a. Application. Contractors desiring a variance from a safety and health standard, or portion thereof, may submit a written application containing the information in paragraphs (c) and (d) of this section to the appropriate CSO.
>
> (1) The CSO may forward the application to the Chief Health, Safety and Security Officer.

(2) If the CSO does not forward the application to the Chief Health, Safety and Security Officer, the CSO must return the application to the contractor with a written statement explaining why the application was not forwarded.

(3) Upon receipt of an application from a CSO, the Chief Health, Safety and Security Officer must review the application for a variance and make a written recommendation to:

(i) Approve the application;
(ii) Approve the application with conditions; or
(iii) Deny the application.

b. Defective applications. If an application submitted pursuant to Sec. 851.31(a) is determined by the Chief Health, Safety and Security Officer to be incomplete, the Chief Health, Safety and Security Officer may:

(1) Return the application to the contractor with a written explanation of what information is needed to permit consideration of the application; or

(2) Request the contractor to provide necessary information.

c. Content. All variance applications submitted pursuant to paragraph (a) of this section must include:

(1) The name and address of the contractor;

(2) The address of the DOE site or sites involved;

(3) A specification of the standard, or portion thereof, from which the contractor seeks a variance;

(4) A description of the steps that the contractor has taken to inform the affected workers of the application, which must include giving a copy thereof to their authorized representative, posting a statement, giving a summary of the application and specifying where a copy may be examined at the place or places where notices to workers are normally posted; and

(5) A description of how affected workers have been informed of their right to petition the Chief Health, Safety and Security Officer or designee for a conference; and

(6) Any requests for a conference, as provided in Sec. 851.34.

(d) Types of variances. Contractors may apply for the following types of variances:

(1) Temporary variance. Applications for a temporary variance pursuant to paragraph (a) of this section must be submitted at least 30 days before the effective date of a new safety and health standard and, in addition to the content required by paragraph (c) of this section, must include:

A statement by the contractor explaining the contractor is unable to comply with the standard or portion thereof by its effective date and a detailed statement of the factual basis and representations of qualified persons that support the contractor's statement;

A statement of the steps the contractor has taken and plans to take, with specific dates if appropriate, to protect workers against the hazard covered by the standard;

A statement of when the contractor expects to be able to comply with the standard and of what steps the contractor has taken and plans to take, with specific dates if appropriate, to come into compliance with the standard;

A statement of the facts the contractor would show to establish that:

The contractor is unable to comply with the standard by its effective date because of unavailability of professional or technical personnel or materials and equipment needed to come into compliance with the standard or because necessary construction or alteration of facilities cannot be completed by the effective date;

The contractor is taking all available steps to safeguard the workers against the hazards covered by the standard; and

The contractor has an effective program for coming into compliance with the standard as quickly as practicable.

(2) Permanent variance. An application submitted for a permanent variance pursuant to paragraph (a) of this section must, in addition to the content required in paragraph (c) of this section, include:

A description of the conditions, practices, means, methods, operations, or processes used or proposed to be used by the contractor; and

A statement showing how the conditions, practices, means, methods, operations, or processes used or proposed to be used would provide workers a place of employment which is as safe and healthful as would result from compliance with the standard from which a variance is sought.

(3) National defense variance. (i) An application submitted for a national defense variance pursuant to paragraph (a) of this section must, in addition to the content required in paragraph (c) of this section, include:

A statement by the contractor showing that the variance sought is necessary to avoid serious impairment of national defense; and

A statement showing how the conditions, practices, means, methods, operations, or processes used or proposed to be used would provide workers a safe and healthful place of employment in a manner that, to the extent practical taking into account the national defense mission, is consistent with the standard from which a variance is sought.

A national defense variance may be granted for a maximum of six months, unless there is a showing that a longer period is essential to carrying out a national defense mission.

f. Discuss the 10 CFR 851 enforcement process.

The Director may initiate and conduct investigations and inspections relating to the scope, nature, and extent of compliance by a contractor with the requirements of this part and take such action as the Director deems necessary and appropriate to the conduct of the investigation or inspection. DOE enforcement officers have the right to enter work areas without delay to the extent practicable, to conduct inspections.

The Director may issue enforcement letters that communicate DOE's expectations with respect to any aspect of the requirements of this part, including identification and reporting of issues, corrective actions, and implementation of the contractor's safety and health program; provided that an enforcement letter may not create the basis for any legally enforceable requirement. The Director may also sign, issue, and serve subpoenas.

DOE encourages settlement of a proceeding under this subpart at any time if the settlement is consistent with this part. The Director and a contractor may confer at any time concerning settlement. The Director may resolve any issues in an outstanding proceeding with a consent order. A consent order must set forth the relevant facts that form the basis for the order and what remedy, if any, is imposed.

Based on a determination by the Director that there is a reasonable basis to believe a contractor has violated or is continuing to violate a requirement of this part, the Director may issue a preliminary notice of violation (PNOV) to the contractor. If a contractor fails to submit a written reply within 30 calendar days of receipt of a PNOV:

- the contractor relinquishes any right to appeal any matter in the preliminary notice;
- the preliminary notice, including any proposed remedies therein, constitutes a final order.

If a contractor submits a written reply within 30 calendar days of receipt of a PNOV, that presents a disagreement with any aspect of the PNOV and civil penalty, the Director must review the submitted reply and make a final determination whether the contractor violated or is continuing to violate a requirement.

Based on a determination by the Director that a contractor has violated or is continuing to violate a requirement, the Director may issue to the contractor a final notice of violation that states concisely the determined violation and any remedy, including the amount of any civil penalty imposed on the contractor. The final notice of violation must state that the contractor may petition the Office of Hearings and Appeals for review of the final notice in accordance with 10 CFR 1003. If a contractor fails to submit a petition for review to the Office of Hearings and Appeals within 30 calendar days of receipt of a final notice of violation pursuant, the contractor relinquishes any right to appeal any matter in the final notice; and the final notice, including any remedies therein, constitutes a final order.

References: 10 CFR 851.20, "Management Responsibilities and Worker Rights and Responsibilities"
10 CFR 851.11, "Development and Approval of Worker Safety and Health Program"
10 CFR 851.31, "Variance Process"

10 CFR 851 parts 40-43, subpart E, "Enforcement Process"
DOE G 440.1-8, *Implementation Guide for Use with 10 CFR Part 851 Worker Safety and Health Program*

13. Personnel shall demonstrate a familiarity level knowledge of the Occupational Safety and Health Act.

a. Using references, discuss the purpose of 29 CFR 1910, Occupational Safety and Health Standards, 29 CFR 1926, Safety and Health Regulations for Construction Industry, and 29 CFR 1960, Basic Program Elements for Federal Employee Occupational Safety and Health and Related Matters.

29 CFR 1910, Occupational Safety and Health Standards

Note: DOE O 440.1A requires DOE contractors to comply with 29 CFR 1910.

The purpose of 29 CFR 1910 is to provide standards for work place safety. It contains several parts of particular applicability to DOE in oversight of contractor safety including

Subpart D – Walking-Working Surfaces
- 1910.23 Guarding floor and wall openings and holes.
- 1910.27 Fixed ladders.
- 1910.28 Safety requirements for scaffolding.

Subpart E – Exit Routes, Emergency Action Plans, and Fire Prevention Plans
- 1910.38 Emergency action plans.
- 1910.39 Fire prevention plans.

Subpart G – Occupational Health and Environment Control
- 1910.94 Ventilation.
- 1910.95 Occupational noise exposure.

Subpart H – Hazardous Materials
- 1910.119 Process safety management of highly hazardous chemicals.
- 1910.120 Hazardous waste operations and emergency response.

Subpart I – Personal Protective Equipment

Subpart J – General Environmental Controls
- 1910.145 Specifications for accident prevention signs and tags.
- 1910.146 Permit-required confined spaces.
- 1910.147 The control of hazardous energy (lockout/tagout).

29 CFR 1926, Safety and Health Requirements for Construction

This regulation sets forth the safety and health standards promulgated by the Secretary of Labor under section 107 of the Contract Work Hours and Safety Standards Act. The standards are published in subpart C of this regulation.

Subpart B of regulation contains statements of general policy and interpretations of section 107 of the Contract Work Hours and Safety Standards Act having general applicability.

29 CFR 1960, Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters

This section contains special provisions to assure safe and healthful working conditions for federal employees. It is the responsibility of the head of each federal agency to establish and maintain an effective and comprehensive occupational safety and health program that is consistent with the standards promulgated under section 6 of the Act. The Secretary of Labor, under section 19 of the Act, is to report to the President certain evaluations and recommendations with respect to the programs of the various agencies.

Requirements include the following:

- 1960.9 Supervisory responsibilities.
- 1960.10 Employee responsibilities and rights.
- 1960.11 Evaluation of occupational safety and health performance.
- 1960.12 Dissemination of occupational safety and health program information.
- 1960.16 Compliance with OSHA standards.
- 1960.25 Qualifications of safety and health inspectors and agency inspections.
- 1960.26 Conduct of inspections.
- 1960.28 Employee reports of unsafe or unhealthful working conditions.
- 1960.29 Accident investigation.
- 1960.30 Abatement of unsafe or unhealthful working conditions.

b. Discuss the regulatory interfaces between the Occupational Safety and Health Administration (OSHA) and other regulatory agencies.

Occupational Safety and Health Administration standards must be incorporated into all federal agency health and safety programs. In addition to OSHA requirements, an agency may be required to comply with additional standards outside the OSHA realm. Although it is not anticipated that agency standards will conflict with OSHA standards, the Secretary of Labor must be notified when a conflict exists. Until the conflict is resolved, the affected agency is expected to comply with the most conservative of the standards.

c. Describe DOE's responsibilities with respect to the Occupational Safety and Health Act.

In 1993, Secretary of Energy Hazel O'Leary announced that DOE would seek external regulation of its Government-Owned Contractor-Operated sites (GOCOs) for occupational safety and health, replacing the current system of self-regulation. A DOE advisory committee subsequently recommended that the Occupational Safety and Health Administration (OSHA) assume jurisdiction for all worker safety and health enforcement issues at DOE sites. A report prepared by the National Academy of Public Administration reiterated and expanded on these issues. (Section 4(b)(1) of the Occupational Safety and Health Act currently preempts OSHA enforcement at DOE GOCOs.)

Since Secretary O'Leary's initial announcement OSHA has continued to work with DOE to prepare for an orderly transition to OSHA external regulation of worker safety and health at GOCO sites. OSHA has participated in three pilot projects at the Argonne National Laboratory, two sites at the Oak Ridge DOE complex, and the Lawrence Berkeley National Laboratory. In May 1998, July 1999, and again in March 2000, OSHA witnesses testified before committees of the U. S. House of Representatives on the Agency's progress in moving towards external regulation of DOE sites. OSHA has identified a number of key issues for an orderly transition, including needed legislation; state plan policies; standards development; training requirements; and resources.

OSHA and DOE have developed a mutually acceptable policy to transfer occupational safety and health enforcement responsibility at privatized facilities and operations located on DOE sites. Privatized facilities and operations are located on DOE sites, but they are leased to private sector enterprises that are not conducting activities for or on behalf of DOE. In July 2000, the agencies entered into a memorandum of understanding on this subject.

In addition, OSHA and DOE also reached final agreement on a list of non-Atomic Energy Act sites, such as fossil fuel and power administration sites. OSHA acknowledges DOE's opinion that DOE does not have Atomic Energy Act enforcement authority at these sites and OSHA, therefore, has safety and health enforcement jurisdiction. In July 2000, OSHA published a Federal Register notice on this subject.

d. Discuss workplace inspection techniques.

OSHA inspections are guided by 29 CFR 1903, "Inspections, Citations, and Proposed Penalties." However OSHA does not perform inspections at DOE facilities. Rather, assessments of worker health and safety programs and their implementation are primarily a responsibility of both the contractor and DOE management who are directing the work activity. Furthermore, DOE has an organization, the Office of Environment, Safety and Health Oversight within the Office of Independent Oversight and Performance Assurance, that provides periodic assessment of worker safety programs.

The independent assessments (i.e., independent of line management) are typically performed every two years at higher hazard sites. The assessment occurs over about a two month period of time and includes scoping, planning, data collection and report writing.

The most intense part of the assessment is the data collection period where a team of about 10 inspectors evaluate the worker safety programs by evaluating the implementation of ISMS at the job task level. This involves evaluating workers as they perform work to determine whether work place hazards have been identified, as well as appropriate hazard controls and whether workers are effectively implementing the controls. In addition to evaluating ISMS at the job task level, assessment of management programs, feedback and improvement, and safety system functionality are typically performed during the independent assessments. The requirements for independent assessments are contained in DOE O 470.2B, *Independent Oversight and Performance Assurance Program.*

e. Discuss the major components of the OSHA hazard communication protocol.

OSHA requirements for hazard communication are contained in 20 CFR 1910.1200. The purpose of this regulation is to ensure that the hazards of all chemicals produced or imported are evaluated, and that information concerning their hazards is transmitted to employers and employees. This transmittal of information is to be accomplished by means of comprehensive hazard communication programs, which are to include container labeling and other forms of warning, material safety data sheets and employee training.

Major components of hazard communication include

- identifying and evaluating a hazardous chemical;
- maintaining an inventory or list of hazardous chemicals and locations;
- labeling of containers of chemicals with the following minimal information:
  - identifying the hazardous chemical;
  - issuing appropriate hazard warnings;
  - providing the name and address of the chemical manufacturer, importer, or other responsible party;
- preparing and distributing material safety data sheets to employees and downstream employers;
- developing and implementing employee training programs regarding hazards of chemicals and protective measures;
- guiding the acquisition of hazardous chemicals;
- guiding the transportation of hazardous materials;
- guiding the handling, use, and storage of hazardous chemicals;
- conducting surveillances.

f. Discuss how the OSHA Rule is invoked on DOE Federal and contractor staff by 10 CFR 851 and DOE Order 440.1, respectively.

Note: DOE O 440.1 has been superseded by DOE O 440.1B.

10 CFR 851 requires contractors to provide a place of employment that is free from recognized hazards that are causing or have the potential to cause death or serious physical harm to workers [851.10(a)(1)]. This provision of the Rule was carried over from DOE O 440.1A and closely parallels the OSHA general duty clause established in Section 5(a)(1) of the OSH Act of 1970 (29 U.S.C. 654) which establishes OSHA's general duty clause. Accordingly, in implementing this provision, contractors should consider criteria similar to those established by OSHA for the implementation of the general duty clause. Specifically, in determining whether a workplace condition presents a recognized hazard that is causing or has the potential to cause death or serious physical harm to workers, contractors should consider whether

- the condition presents a hazard to which workers are exposed (e.g., the hazard exists and workers are exposed to the hazard);
- the hazard is a recognized hazard (e.g., the hazard is identified and addressed in a recognized industry consensus standard, or other credible industry guidance or documentation);
- the hazard is causing or is likely to cause death or serious physical harm;
- feasible and useful methods exist to correct the hazard.

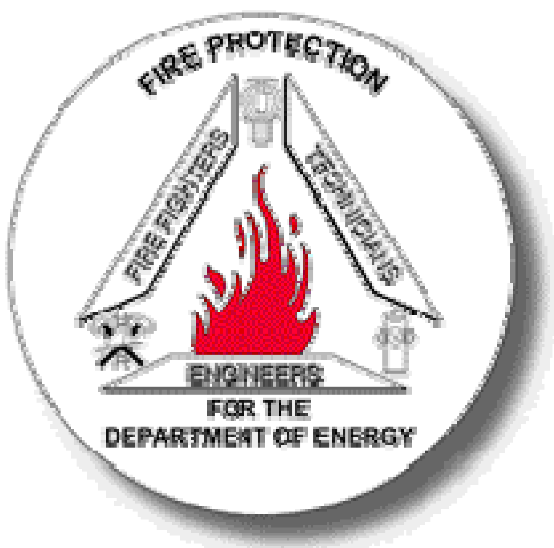
References: 29 CFR 1910.119, "Process Safety Management for Highly Hazardous Chemicals"
DOE O 225.1A, *Accident Investigations*
29 CFR 1910, "Occupational Safety and Health Standards"

29 CFR 1960, “Basic Program Elements for Federal Employee Occupational Safety and Health and Related Matters”
29 CFR 1926, “Safety and Health Regulations for Construction”
DOE O 440.1B, *Worker Protection Management for DOE Federal and Contractor Employees*
DOE O 470.2B, *Independent Oversight and Performance Assurance Program*
DOE G 450.4-1B, *Integrated Safety Management System Guide*
48 CFR 970.5223, “Integration of Environment, Safety, and Health into Work Planning and Execution”
U.S. Department of Labor, *Background: DOE Transition*

14. Personnel shall demonstrate a familiarity level knowledge of fire safety for Department facilities necessary to identify safe/unsafe work practices.

Background

“Fire protection” is a broad term that encompasses all aspects of fire safety, including building construction and fixed building fire features, fire suppression and detection systems, fire water systems, emergency process safety control systems, emergency fire fighting organizations (fire departments, fire brigades, etc.), fire protection engineering, and fire prevention. Fire protection is concerned with preventing or minimizing the direct and indirect consequences of fire. It also includes aspects of the following perils as they relate to fire protection: explosion, natural phenomenon, and smoke and water damage from fire. Information from the fire protection program shall be incorporated in the emergency plan. The facility fire protection organization shall be involved in developing the emergency plan and in all related training and drills.



The objectives of DOE fire protection program are to

- minimize the potential for the occurrence of a fire or related event;
- ensure that a fire doe not cause an unacceptable onsite or onsite release of hazardous or radiological material that will threaten the health and safety of employees, the public, or the environment;

- establish requirements that will provide an acceptable degree of life safety to DOE and contract employees;
- ensure vital DOE programs will not suffer unacceptable interruptions a result of fire and related hazards;
- ensure property losses from a fire and related events will not exceed defined limits established by DOE; and
- ensure critical process controls and safety class systems are not damaged as a result of a fire and related events.

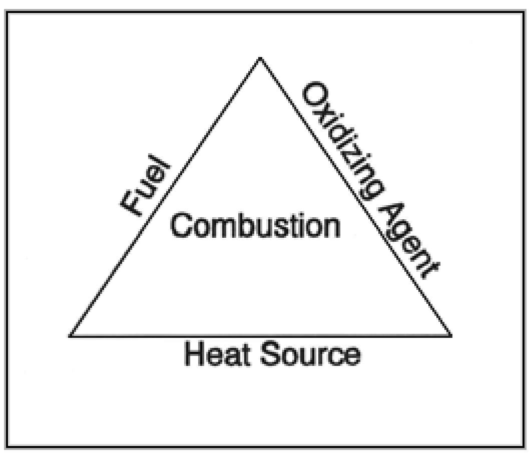
DOE O 420.1B, *Facility Safety,* and DOE O 440.1B, *Worker Protection Management for DOE,* provide requirements for fire protection programs at DOE sites.

a. Discuss the critical aspects of fire prevention, fire response planning, and control of fires.

Fire Prevention

Critical aspects of fire prevention include limiting combustibles, proper design and maintenance of systems (e.g., electrical systems), ensuring proper hot work permits are obtained and followed, and establishing fire watches when needed for certain type of work activities.

Three factors are needed to support and continue fire: fuel, air (or oxidizing agent), and sufficient high temperature. This is known as the fire triangle. Removing any of these factors will prevent (or put out) the fire.



Fire triangle

Emergency Planning

Critical aspects of emergency planning include determining fire response needs (response equipment, alarm and communication, personnel, and response times), establishing and maintaining the resources and equipment, and training and drilling response personnel as well as workers.

DOE requires that "pre-fire plans" be developed so that fire department and facility personnel can exchange critical information that can be used to mitigate an emergency situation including information on

- building occupancy, type of construction, and contents (e.g., hazardous materials);
- onsite fire protection features including water supply;
- access;
- interagency assistance.

Control of Fires

Critical aspects of control of fires include fire suppression systems and training of employees and fire response personnel.

Fire suppression systems are categorized as water-based, gaseous, or dry-chemical systems:

- Water based: automatic sprinkler, fixed water spray, and foam-water systems
- Gaseous: carbon dioxide, halon, or halon replacement agents ("clean agents")
- Dry chemical: variety of agents based upon material to be extinguished

b. Describe fire hazards that could affect the safety of facility personnel.

A fire hazard exists any time you have the combination of a heat energy source, combustible material (fuel), and available oxygen. Plutonium is a material that is its own heat source and can be pyrophoric under certain conditions and forms. Other combustible materials can be fire hazards in a facility and thus require controls such as maximum allowed quantities and proper storage locations. Electrical fires can occur due to excessive loading of circuits and poorly maintained electrical/electronic equipment.

In 1997 a fatality occurred at a DOE site when a worker's anti-contamination clothing caught on fire when sparks from welding landing on the clothing.

c. Discuss the key elements of the National Fire Protection Association (NFPA) Life Safety Code.

One of the fundamental principles of fire protection is that structures be designed so that the occupants of the building can safely escape during a fire event. NFPA 101 provides consensus "life safety" standards for fire protection that DOE has adopted for its buildings.

The NFPA Life Safety Code (NFPA 101)

- addresses life safety from fire and similar emergencies;
- addresses those construction, protection, and occupancy features necessary to minimize danger to life from fire, smoke, fumes, or panic;
- identifies the minimum criteria for the design of egress facilities so as to permit prompt escape of occupants from buildings or, where desirable, into safe areas within the building;
- recognizes that life safety is more than a matter of egress and, accordingly, deals with other considerations that are essential to life safety.

Fundamental Requirements

The fundamental requirements, quoted below, are the key elements that are further elaborated upon for specific building occupancy types later in the Code:

- Every building or structure, new or old, designed for human occupancy shall be provided with exits and other safeguards sufficient to permit the prompt escape of occupants or furnish other means to provide a reasonable degree of safety for occupants in case of fire or other emergency. The design of exits and other safeguards shall be such that reliance for safety to life in case of fire or other emergency will not depend solely on any single safeguard; additional safeguards shall be provided for life safety in case any single safeguard is ineffective due to some human or mechanical failure.
- Every building or structure shall be so constructed, arranged, equipped, maintained, and operated as to avoid undue danger to the lives and safety of its occupants from fire, smoke, fumes, or resulting panic during the period of time reasonably necessary for escape from the building or structure or for that period of time needed to defend in place in case of fire or other emergency.
- Every building or structure shall be provided with exits and other safeguards of kinds, numbers, locations, and capacities appropriate to the individual building or structure, with due regard to the character of the occupancy, the capabilities of the occupants, the number of persons exposed, the fire protection available, the height and type of construction of the building or structure, and other factors necessary to provide all occupants with a reasonable degree of safety.
- In every building or structure, exits shall be so arranged and maintained as to provide free and unobstructed egress from all parts of the building or structure at all times when it is occupied. No lock or fastening shall be installed to prevent free escape from the inside of any building. Exits shall be accessible to the extent necessary to assure reasonable safety for occupants having impaired mobility.
- Every exit shall be clearly visible, or the route to reach every exit shall be conspicuously indicated in such a manner that every occupant of every building or structure who is physically and mentally capable will readily know the direction of escape from any point. Each means of egress, in its entirety, shall be so arranged or marked that the way to a place of safety is indicated in a clear manner. Any doorway or passageway that is not an exit or a way to reach an exit, but is capable of being confused with an exit shall be so arranged or marked to prevent occupant confusion with acceptable exits. Every effort shall be taken to avoid occupants mistakenly traveling into dead-end spaces in a fire emergency.
- Where artificial illumination is required in a building or structure, exit facilities shall be included in the lighting design in an adequate and reliable manner.
- In every building or structure of such size, arrangement, or occupancy that a fire itself may not provide adequate occupant warning, fire alarm facilities shall be provided where necessary to warn occupants of the existence of fire. Fire alarms will alert occupants to initiate emergency procedures. Fire alarms facilitate the orderly conduct of fire exit drills.
- Two means of egress, as a minimum, shall be provided in every building or structure, section, and area where their size, occupancy, and arrangement endanger occupants attempting to use a single means of egress that is blocked by fire or smoke. The two

means of egress shall be arranged to minimize the possibility that both may be rendered impassable by the same fire or emergency condition.

- Every vertical way of exit and other vertical opening between floors of a building shall be suitably enclosed or protected, as necessary, to afford reasonable safety to occupants while using exits and to prevent spread of fire, smoke, or fumes through vertical openings from floor to floor before occupants have entered exits.
- Compliance with the Code shall not be construed as eliminating or reducing the necessity for other provisions for safety of persons using a structure under normal occupancy conditions. Also, no provision of the Code shall be construed as requiring or permitting any condition that may be hazardous under normal occupancy conditions.

d. Discuss the purpose of fire hazard analysis.

The purpose of a fire hazards analysis (FHA) is to comprehensively assess the risk from fire within individual fire areas in a DOE facility in relation to existing or proposed fire protection to determine if the objectives of DOE Orders are met. The FHA is developed using a graded approach, and is incorporated into the facility's safety analysis report (SAR), design-basis, and beyond-design-basis accident conditions.

A FHA includes an evaluation of

- the combustibles within a given fire area (e.g., combustible liquids, plastics, wood structures); and
- potential ignition sources (e.g., electrical equipment, heat generated by friction, heated equipment).

Fire hazards are controlled by minimizing and segregating the hazards so that potential fires are limited to a manageable magnitude.

DOE requirements for a FHA are contained in DOE O 420.1A. An example FHA can be found at the DOE fire protection web site (http://www.eh.doe.gov/fire/).

e. Describe the characteristics and methods/agents used to extinguish the following classes of fires:

- **Class A**
- **Class B**
- **Class C**
- **Class D**

Background

Fires can be extinguished by the following four basic methods:

- Physically separating the combustible substance from the flame
- Removing or diluting the oxygen supply
- Reducing the temperature of the combustible or the flame
- Introducing chemicals that modify the combustion chemistry

Class A

These are fires involving combustibles such as wood, paper, cloth, etc. These fires are typically extinguished with water or a dry chemical fire extinguisher. Halon is also effective. Carbon dioxide may also be used but is only effective for small fires.

Ordinary Combustibles

Class B

These are fires involving liquids (e.g., lubricating oil, fuel oil, diesel fuel, gasoline, kerosene, etc.). These fires are extinguished with a foaming agent, a chemical agent such as PKP, or a dry chemical fire extinguisher. A water fog is marginally effective if applied properly. Halon can be effective also.

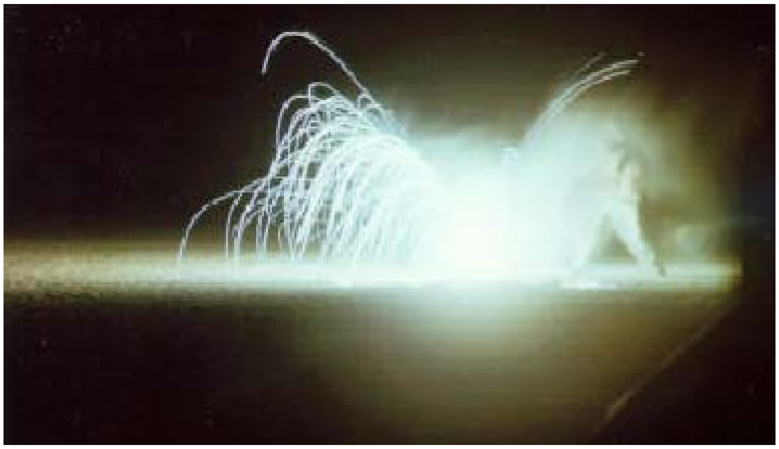
Class C

These are fires involving electrical circuits. The circuit must be de-energized to remove the heat source. Carbon dioxide and halon are the principal extinguishing agents. Water is not used due to the associated shock hazard if the circuits are energized. Chemical agents are also not recommended due to their corrosive nature, although a dry chemical fire extinguisher would be effective against a class C fire.

Electrical Equipment

Class D

These are fires involving burning metal (e.g., plutonium, magnesium, sodium, lithium, etc.). These fires are typically extinguished using an inert smothering agent such as magnesium oxide, sand, or a dry powder fire extinguisher. Metallic fires burn at the surface, are very hot, and are extremely hard to put out because of the extreme heats that are produced. Plutonium will continue burning in relatively low oxygen concentration environments once the process gets started.



f. Discuss the key components and use of building fire protection equipment, including detection, alarm, and communication systems, and extinguishing systems (automatic and manual).

Fire protection consists of a comprehensive system of defense against the fire hazard for the benefit of personnel and the facility. It starts with good fire prevention practices (good housekeeping, proper storage of flammable materials, minimizing combustible loading, etc.) and facility design (use of fire walls, fire doors in glove box lines, sprinkler and other suppression systems, avoidance of layouts that promote updrafts, etc.). Next comes the use of fire detection systems as close to the potential sources as possible (e.g., storage trays equipped with heat detection in the glove boxes, temperature probes in the ventilation ducting before reaching the plenums, trained operators, etc.). Detection systems are used to drive alarms to warn personnel and alert fire department personnel, and to activate automatic fire suppression systems.

Key components of fire protection equipment include detection, alarm, communication, and manual/automatic extinguishing systems.

Communication systems enable operating personnel to quickly notify the fire department and other facility personnel of a fire condition through the use of pull-stations and/or sound-powered phones, with direct lines to the fire department, at or close to operating stations. Fire suppression (extinguishing) systems include sprinkler systems, plenum deluge systems, halon discharge systems, and carbon dioxide discharge systems that activate either automatically or manually. Portable extinguishers are installed throughout the facility to enable trained personnel to take immediate action to control a small fire before it spreads into a larger one, until the fire department can arrive. A supervisory alarm system is also used to detect faults in the system. Periodic surveillance testing ensures that fire panels and detectors are continuously operable.

References: DOE O 420.1B, *Facility Safety*
DOE O 440.1B, *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*
DOE-STD-1066-99, *Fire Protection Design Criteria*
DOE-STD-1088, *Fire Protection for Relocatable Structures*
DOE-HDBK-1062, *DOE Fire Protection Handbook*
DOE-HDBK-1081, *Primer on Spontaneous Heating and Pyrophoricity*

15. Personnel shall demonstrate a familiarity level knowledge of electrical safety for Department facilities necessary to identify safe/unsafe work practices.

a. Discuss general safety precautions for working around electrical equipment, both low and high voltage.

It is usual for facilities to have equipment that operates at less than 50 V. Although this equipment is generally regarded as non-hazardous, it is considered hazardous when high currents are involved. Examples of such equipment are a power supply rated 3 kA at 25 V, a magnet power supply with rated output of 200 A at 40 V, and a bus bar carrying 1 kA at 5 V.

Though there is a low probability of electric shock at voltages less than 50 V there is a hazard due to arcing and heating in case of an accidental fault. For example, a tool could drop onto the terminals and initiate an arc, causing severe burns.

A circuit operating at 50 V or less shall be treated as a hazardous circuit if the power in it can create electrical shocks, burns, or an explosion due to electric arcs. Observe all of the following rules for such circuits:

- Provide protective covers and/or barriers over terminals and other live parts to protect personnel.
- By suitable marking, identify the hazard at the power source and at appropriate places.
- Consider magnetic forces in both normal-operation and short-circuit conditions. Use conductors that have appropriate physical strength and are adequately braced and supported to prevent hazardous movement.
- Inductive circuits may create high-voltage hazards when interrupted. Careful circuit design will include a method to bleed off power safely should an interruption occur.

Follow these guidelines for working on circuits operating at 50 V or less that are treated as hazardous:

- Work on such circuits when they are de-energized.
- If it is essential to work on or near energized low-voltage, high-current circuits, observe the safety rules as if the circuits were operating at more than 50 V.

When the output current of high-voltage supplies is below 5 mA, the shock hazard to personnel is low. Where combustible atmospheres or mixtures exist, the hazard of ignition from a spark may exist. High-voltage supplies (ac or dc) can present the following hazards:

- Faults, lightning, or switching transients can cause voltage surges in excess of the normal ratings.

- Internal component failure can cause excessive voltages on external metering circuits and low-voltage auxiliary control circuits.
- Over-current protective devices such as fuses and circuit breakers for conventional applications may not adequately limit or interrupt the total inductive energy and fault currents in highly inductive dc systems.
- Stored energy in long cable runs can be an unexpected hazard. Safety instructions should be in place to ensure proper discharge of this energy.
- Secondary hazards such as startle or involuntary reactions from contact with high-voltage low-current systems may result in a fall or entanglement with equipment.

An analysis of high-voltage circuits should be performed by a qualified person before work begins unless all exposed energized parts are guarded as required for high-voltage work. The analysis must include fault conditions where circuit current could rise above the nominal rated value. Depending on the results of the analysis, any of the following may apply:

- If the analysis concludes that the current is above 5 mA or energy is above 10 joules, then the work is considered to be energized work and should be performed in accordance with DOE-HDBK-1092-2004, section 2, "General Requirements" and/or section 7, "Work In Excess of 600 Volts."
- If the analysis concludes that the current is between 0.5 mA and 5 mA and between 0.25 and 10 joules, then the worker may be exposed to a secondary hazard (e.g., startle reaction) that must be mitigated.
- If the analysis concludes that the current is below 0.5 mA and below 0.25 joules, then the worker exposure is minimal and no special precautions are required.
- High-voltage supplies that use rated connectors and cables where there are no exposed energized parts are not considered hazards. Connections shall not be made or broken with the power supply energized unless they are designed and rated for this type of duty (e.g., load break elbows). Inspect cables and connectors for damage and do not use if they are damaged.
- Exposed high-voltage parts must be guarded to avoid accidental contact.

b. Describe basic electrical isolation devices and methods.

Electrical hazards exist when wires or other electrical parts are exposed. These hazards need to be controlled to create a safe work environment. Isolation of energized electrical parts makes them inaccessible unless tools and special effort are used. Isolation can be accomplished by placing the energized parts at least 8 feet high and out of reach, or by guarding. Guarding is a type of isolation that uses various structures-like cabinets, boxes, screens, barriers, covers, and partitions-to close-off live electrical parts.

c. Describe how safety considerations differ for alternating and direct current.

Personal protective equipment and work practices are established for AC voltages above 50 volts. For DC voltages the focus is on shock effect for currents above 100 milliamps. AC safe work practices would target voltage (for shocks and arc flash events), whereas DC safe work practices would target current values above the 100mA threshold. In summary, the concern with AC safety is related to voltage, while the focus is on current when addressing DC safety.

d. Describe basic office electrical safety precautions.

Electricity is essential to the operations of a modern automated office as a source of power. Electrical equipment used in an office is potentially hazardous and can cause serious shock and burn injuries if improperly used or maintained. Electrical accidents usually occur as a result of faulty or defective equipment, unsafe installation, or misuse of equipment on the part of office workers.

General Electrical Safety Tips

- Replace or repair loose or frayed cords on all electrical devices.
- Avoid running extension cords across doorways or under carpets.
- In areas with small children, electrical outlets should have plastic safety covers.
- Follow the manufacturer's instructions for plugging an appliance into a receptacle outlet.
- Avoid overloading outlets. Consider plugging only one high-wattage appliance into each receptacle outlet at a time.
- If outlets or switches feel warm, shut off the circuit and have them checked by an electrician.
- When possible, avoid the use of "cube taps" and other devices that allow the connection of multiple appliances into a single receptacle.
- Place lamps on level surfaces, away from things that can burn, and use bulbs that match the lamp's recommended wattage.

Outlet Safety

The outlet, or receptacle, is perhaps the most commonly used and least thought of device in the office. Every electrical appliance, tool, computer, and entertainment center component we use is powered through one. Here are some simple but important safety principles:

- Check outlets regularly for problems, including over-heating, loose connections, reversed polarity, and corrosion. An electrical inspection should be performed by a qualified, licensed electrician to help determine the integrity of the outlets and the entire electrical system.
- Check for outlets that have loose-fitting plugs, which can lead to arcing and fire.
- Avoid overloading outlets with too many appliances. Never plug more than one high-wattage appliance in at a time in each.
- Check for any hot or discolored outlet wall plates. Look from across the room; sometimes you'll see a darkened area in a teardrop shape around and above the outlet that may indicate dangerous heat buildup at the connections.
- Warm to the touch is OK, hot is not. If an outlet or switch wall plate is hot to the touch, immediately shut off the circuit and have it professionally checked.
- Replace any missing or broken wall plates.

Power Cords

We can sometimes get so caught up in the safety awareness of our appliances and lamps that we forget about the safety principles that relate to its power cord. An appliance can look like it's in good operating order and yet still represent a hazard if its cord is damaged.

- Don't use power cords if they are frayed, cracked, or cut.

- Make sure all power cords and extension cords are in good condition, not frayed, cracked, or cut. If the power cord to a lamp or appliance is damaged, take the item to an authorized service center, or cut the power cord and dispose of the item safely. Cutting the cord helps ensure that no one else will pick up the item and take the hazard home with them.
- Never attempt to repair or splice a cut cord yourself. "Electrical" tape, as commonly referred to – usually black vinyl tape – is not rated for the heat generated by electricity running through wires. The tape will melt and burn.
- Make sure all electrical items, including appliances, extension cords, and surge suppressors, are certified by a nationally recognized independent testing lab, such as Underwriters Laboratories (UL), Canadian Standards Association (CSA), ETL Testing Laboratories, or MET Laboratories.
- Do not coil power cords when in use.
- Do not place power cords in high traffic areas or under carpets, rugs, or furniture.
- Power cords should never be nailed or stapled to the wall, baseboard, or another object.
- Make sure appliances are turned off before connecting cords to outlets.
- Never remove the ground pin (the third prong) to make a three-prong plug fit into a two-prong outlet; this could lead to an electrical shock.
- Never force a plug into an outlet. Plugs should fit securely into outlets, but should not require much force to fit.
- Make sure to fully insert the plug into the outlet.
- Unplug appliances when not in use to conserve energy but also to minimize the opportunities for electric shock or fire.

Extension Cords

Extension cords are temporary solutions only, and yet the majority of homes have at least one extension cord plugged in and left in place. Continual use can cause the insulation to rapidly deteriorate, creating a dangerous shock and fire hazard. In addition to the same safety tips that apply to power cords, keep the following principles in mind when using extension cords:

- Extension cords should only be used on a temporary basis; they are not intended as permanent household wiring.
- A heavy reliance on extension cords is an indication that you have too few outlets to address your needs. Have additional outlets installed where you need them.
- Make sure extension cords are properly rated for their intended use, indoor or outdoor, and meet or exceed the power needs of the appliance or tool being plugged into it.
- Assume 125 watts per amp when converting to determine if the extension cord you intend to use is properly rated for the appliance being connected to it. For example, if your appliance indicates that it uses 5 amps at 125 volts, then its wattage rating is 625 watts (5 amps X 125 watts).

Power Strips and Surge Suppressors

Power strips give us the ability to plug more products into the same outlet, which can be a help but also a hindrance to safety if used inappropriately. Power strips and surge suppressors don't provide more power to a location, just more access to the same limited capacity of the circuit into which it is connected. The circuit likely also still serves a variety of other outlets and fixtures in addition to the multiple electrical items you might be serving with the power strip. In addition to the tips above, keep these safety principles in mind when using power strips and surge suppressors:

- Be sure you are not overloading the circuit. Know the capacity of the circuit and the power requirements of all the electrical items plugged into the power strip and into all the other outlets on the circuit, as well as the light fixtures on the circuit.
- A heavy reliance on power strips is an indication that you have too few outlets to address your needs. Have additional outlets installed where you need them.
- Understand that a surge suppressor only protects the items plugged into it, not back along the circuit into which it is connected.
- Surge suppressors can manage the small surges and spikes sometimes generated by the turning on and off of appliances. They may even protect against a large surge generated from outside sources like lightning or problems along the power lines to the office or house. In the event of a large surge or spike, the surge suppressor is a one-time-use protector and will likely have to be replaced.
- Consider purchasing surge suppressors with cable and phone jacks to provide the same protection to your phone, fax, computer modem, and television.
- Not all power strips are surge suppressors, not all surge suppressors can handle the same load and events. Be sure the equipment you buy matches your needs.

e. Discuss NFPA 70E, Standard for Electrical Safety in the Workplace.

This standard addresses those electrical safety requirements for employee workplaces that are necessary for the practical safeguarding of employees in their pursuit of gainful employment. This standard covers the installation of electric conductors, electric equipment, signaling and communications conductors and equipment, and raceways for the following: (1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings (2) Yards, lots, parking lots, carnivals, and industrial substations FPN: For additional information concerning such installations in an industrial or multibuilding complex, see ANSI C2-2002, *National Electrical Safety Code.* (3) Installations of conductors and equipment that connect to the supply of electricity (4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generating plant, substation, or control center.

References: DOE-HDBK-1092-2004, *Electrical Safety*
National Institute for Occupational Safety and Health, Electrical Safety, section 7 Safety Model Stage 3-*Controlling Hazards: Safe Work Environment*
Texas State Office of Risk Management, *Office Safety*, Office Electrical Safety
National Fire Protection Association, NFPA 70E, *Standard for Electrical Safety in the Workplace*

16. Personnel shall demonstrate a familiarity level knowledge of industrial hygiene principles.

a. Define the term "industrial hygiene," including the elements of anticipation, recognition, evaluation and control of health hazards in the workplace.

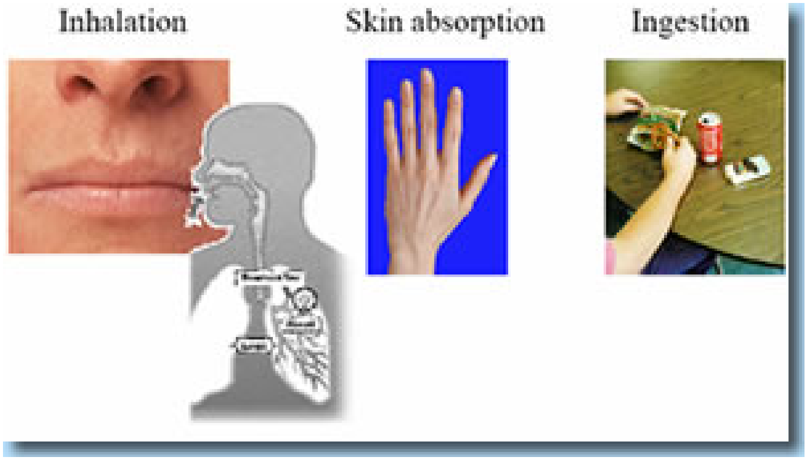
Industrial hygiene is the science of anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness. Industrial hygienists use environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls, and other methods to control potential health hazards.

b. Discuss basic industrial hygiene concepts and terminology, including the following:

- **Routes of exposure (inhalation, ingestion, dermal injection)**
- **Dose and toxicity (acute, chronic, concentration)**
- **Exposure limits [permissible exposure limits (PEL), time-weighted average (TWA), threshold limit values (TLV), short term exposure limit (STEL), ceiling, action level, parts per million (PPM), milligrams per cubic meter (mg/m^3)]**
- **Hierarchy of controls (engineering, substitution, administrative, PPE)**
- **Health hazards (chemical, physical, biological)**
- **Key elements of a carcinogen control program, including carcinogenic chemicals and asbestos control**

Routes of Exposure

There are four basic routes of exposure; inhalation, ingestion, absorption through the skin, injection. The inhalation route is uptake through the pulmonary system, usually the greatest concern, regardless of the form of the hazard. Ingestion is usually a minor route involving the GI tract uptake by eating or swallowing contaminated food. Skin absorption is uptake through the skin. Some materials will readily penetrate the skin barrier or through cuts or abrasions. Injection can be, for example, via a needle or via a contaminate located on a broken piece of glass that penetrates the skin..



Dose and Toxicity

Dose is determined by exposure to a given concentration of a substance for a given period of time.

Toxicity of a substance is determined by the effect on the body.

Hazard is determined by the toxicity, dose and susceptibility of the individual.

Acute exposure is defined as short term, one time event.

Chronic exposure is the continual, repeated, ongoing event.

The degree of hazard is a function of chemical compound or type of energy and its toxicity or action on the body; the rate or intensity of exposure; duration of exposure; and the susceptibility of the person.

Exposure Limits

TLV (ACGIH version of occupational health exposure standard)–The concentration to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

PEL–An exposure limit that is published and enforced by the Occupational Safety and Health Administration (OSHA) as a legal standard.

TWA–The average exposure measured over an entire shift.

STEL–The concentration to which workers can be exposed continuously for a short period of time.

Ceiling Limit–The concentration that should not be exceeded during any part of the working exposure

Action Level–An administrative control limit set below the PEL (usually one-half) ppm (parts per million) mg/m^3(milligram per cubic meter of air).

Hierarchy of Controls

The following is the hierarchy of controls (primary, secondary, etc.):

- Engineering controls include eliminating toxic chemicals and replacing toxic materials with less hazardous, enclosing work processes or confining work operations, and installing general and local ventilation system.
- Work practice controls alter the manner in which a task is performed such as following proper procedures that minimize exposures, inspecting and maintaining equipment, good housekeeping procedures, etc.
- Administrative controls include controlling employees' exposure by scheduling production and workers' tasks or both in ways that minimize exposure levels such as scheduling the highest exposure potential operations during periods when the fewest employees are present.

Personal Protective Equipment

When effective work practices and/or engineering controls are not feasible to achieve the PEL, or while such controls are being instituted, and in emergencies, appropriate PPE (i.e., respiratory equipment) must be used.

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Health Hazards

Air contaminants are classified as either particulate, gas or vapor contaminants. Particulate contaminants include dusts, fumes, mists, aerosols and fibers. Gases are formless fluids that expand to occupy the space or enclosure in which they are confined. Vapors are the volatile form of substances that are normally in a solid or liquid state at room temperature and pressure.

Harmful chemical compounds in the form of solids, liquids, gases, mists, dusts, fumes and vapors exert toxic effects by inhalation (breathing), absorption (through direct contact with the skin), or ingestion (eating or drinking).

- Biological hazards include bacteria, viruses, fungi, and other living organisms that can cause acute and chronic infections by entering the body either directly or through breaks in the skin.
- Physical hazards include non-ionizing and electromagnetic radiation (laser and microwave), noise, vibration, illumination, and temperature.

- Ergonomic hazards or conditions such as excessive vibration and noise, eye strain, repetitive motion and heavy lifting problems are caused by poorly designed job tasks.

Key Elements of a Carcinogen Control Program

A policy and procedures should be established and implemented to control occupational exposure to chemical carcinogens. For OSHA-regulated carcinogens, control procedures shall be implemented that, at a minimum, conform to the requirements of respective OSHA standards. For other carcinogens, control procedures shall be implemented that are consistent with the current ACGIH Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Controls will depend on the physical and chemical properties of the material, how it will be handled (specifically if the material will be handled in a way where it could be dispersed into the air or spread on surfaces), the quantity involved, and the duration and number of potential exposures. Generally, the following controls should be applied to the use and handling of chemical carcinogens:

- Written safety plans, standard operating procedures, and/or experimental protocols should be prepared to describe the use of chemical carcinogens and the methods used to control employee exposure. These documents should be reviewed and approved by the senior industrial hygienist prior to the initiation of an operation.
- Regulated areas should be established where chemical carcinogens are used (consistent with OSHA requirements, where applicable). The design and characteristics of these regulated areas should be appropriate to ensure that access is controlled and all carcinogenic materials are confined. A record should be maintained of all personnel working in regulated areas. Provisions should be made to ensure that contaminated air is not released into adjacent, non-regulated work areas or to the outside environment.
- Engineering control should be the primary method used to control employee exposure to carcinogens and to prevent the release of carcinogens into the workroom environment. All contaminated wastes and materials should be stored and disposed of using approved methods.
- Signs warning of the presence of chemical carcinogens should be posted at all entrances to regulated work areas. Appropriate labeling should be used on all chemical carcinogen containers and contaminated wastes to identify and warn of the carcinogenic hazard.
- Appropriate personal hygiene and work practices should be implemented, including use of protective clothing, shower facilities, change rooms, prohibition on eating, drinking, and smoking in regulated areas, and the use of non-permeable work surfaces, as feasible.

- Procedures should be established for emergency actions involving chemical carcinogens (e.g., cleanup of spills or accidental releases). Occurrences that could result in exposure of personnel or release to the environment should be investigated and, if appropriate, reported.

c. Discuss the key elements (exposure assessment and monitoring, engineering controls, respiratory protection, PPE and clothing, housekeeping, labeling, training, medical surveillance, record keeping) of an industrial hygiene program.

Exposure Assessment and Monitoring

This element is used to identify air contaminants; estimate employee exposures; characterize an environment generally; identify and quantify emission sources; check the effectiveness of emission and exposure controls; and check for compliance with standards.

Housekeeping

Housekeeping includes actions to be taken such as wet mopping or vacuuming to lower the exposure potential in an environment known to have exposure potential above federal limits as in asbestos and lead abatement operations.

Engineering Controls

These types of controls (process change, substitution, isolation, ventilation, source modification) depend on regulatory requirements (some operations require specific controls like local exhaust ventilation), the nature of the hazard and the way it affects the employee like the route of entry to the body for chemicals hazards.

Respiratory Protection

When environmental, administrative and engineering controls are not available, appropriate respirators may be used to provide employee protection. Respirators may be used in environments in which the atmospheric conditions (chemical concentrations) are immediately dangerous to life and health (IDLH) and those which are not. Respiratory protection programs should be administered by a qualified individual and prescribe the type of respiratory protection (National Institute for Occupational Safety and Health (NIOSH) / Mine Safety and Health Administration (MSHA) certified) required for each assessed hazard.

Labeling

Signs which alert employees of the presence of a hazardous chemical or environment, precautions to be taken, and entry requirements posted at all entrances to regulated areas.

Training Requirements

Material, guidelines, and instructions that provide basic knowledge of the hazards of the material or process, potential health risks, available employee protection, and proper use of controls.

Medical Surveillance

The systematic collection, analysis, and evaluation of health data to identify disease cases, patterns, or trends suggesting adverse health effects and the need for further investigation, evaluation, and/or remedial action.

Recordkeeping

Establish and maintain accurate records of all hazards inventory information, hazard assessments, exposure measurements, exposure controls and medical surveillance.

d. Discuss industrial hygiene requirements as found in the following regulations:

- **10 CFR 850, Chronic Beryllium Disease Prevention Program**
- **10 CFR 851, Worker Safety and Health Program Discuss Industrial Hygiene Requirements**

10 CFR 850

The Chronic Beryllium Disease Prevention Program (CBDPP) must specify the existing and planned operational tasks that are within the scope of the CBDPP. The CBDPP must augment and, to the extent feasible, be integrated into the existing worker protection programs that cover activities at the facility.

The detail, scope, and content of the CBDPP must be commensurate with the hazard of the activities performed, but in all cases the CBDPP must

- include formal plans and measures for maintaining exposures to beryllium at or below the permissible exposure level prescribed in 10 CFR 850.22;
- satisfy each requirement in subpart C of 10 CFR 850;
- contain provisions for
  - minimizing the number of workers exposed and potentially exposed to beryllium;
  - minimizing the number of opportunities for workers to be exposed to beryllium;
  - minimizing the disability and lost work time of workers due to chronic beryllium disease, beryllium sensitization and associated medical care;
  - setting specific exposure reduction and minimization goals that are appropriate for the beryllium activities covered by the CBDPP to further reduce exposure below the permissible exposure limit prescribed in 10 CFR.

10 CFR 851

With respect to a covered workplace for which a contractor is responsible, the contractor must

- provide a place of employment that is free from recognized hazards that are causing or have the potential to cause death or serious physical harm to workers;
- ensure that work is performed in accordance with
  - all applicable requirements of this part;
  - the worker safety and health program for that workplace.

The written worker safety and health program must describe how the contractor complies with

- the requirements set forth in subpart C of 10 CFR 851 that are applicable to the hazards associated with the contractor's scope of work;
- any compliance order issued by the Secretary pursuant to 10 CFR 851.4.

e. Discuss the key elements of a hazards communication program and the use of material safety data sheets.

The purpose of a hazards communication program is to ensure that employees are properly informed about chemical hazards in the workplace. This is accomplished by maintaining lists of hazardous chemicals site-wide, by using MSDSs in the workplace, by properly labeling chemical containers, and by training.

MSDSs are required by the Occupational Safety and Health Administration's hazards communication standard. They provide information concerning chemical hazards and control measures necessary to ensure a safe work environment when working with specific materials. Copies of MSDSs are maintained in binders in each workplace. A master file of all MSDSs in use site wide is maintained by industrial hygiene personnel.

Each MSDS must be in English and contain at least the following information:

- Manufacturer's information – name, address, and telephone number of the chemical manufacturer, importer, or other responsible party who can provide additional information on the hazardous chemical
- Hazardous ingredients/identity information – the chemical and common name(s) of the ingredient(s) that contribute to the known hazards and the common name(s) of the mixture itself

- Physical/chemical characteristics of the material – such as liquid, solid, or gas; color; corrosivity; and reactivity
- Fire and explosion hazard information – such as vapor pressure and flash point
- The primary route(s) of entry into the body
- Health hazard data – the health hazards of the hazardous chemical, including signs and symptoms of exposure, and any medical conditions that are recognized as being aggravated by exposure to the chemical
- The OSHA permissible exposure limit, American Conference of Governmental Industrial Hygienist's threshold limit value, and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the MSDS
- Whether the hazardous chemical is carcinogenic or potentially carcinogenic based on various reports
- Precautions for safe handling and use – any generally applicable precautions for safe handling and use that are known, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks
- Emergency and first aid procedures
- Control measures – any generally applicable control measures that are known, such as appropriate engineering controls, work practices, or personal protective equipment
- Date of preparation of the MSDS

Some information from an MSDS is transcribed to a hazard-warning label. All containers with hazardous chemicals must be labeled. Typically, the label is provided by the manufacturer. If for some reason a container doesn't have a manufacturer's warning label, one will be affixed locally.

See Appendix for examples of MSDS.

f. Discuss the importance of the following types of equipment used for personnel protection and safety:

- **Eye protection**
- **Ear protection**
- **Protective clothing/gloves**
- **Respiratory protection**

Eye Protection

Eye and face protection requirements for work activities are determined by the job supervisor with assistance from occupational safety and industrial hygiene personnel. All personnel are required to obey posted eye protection requirements.

- Class I. Safety glasses that meet the requirements of ANSI Standard Z87, *American National Standard Practice for Occupational and Educational Eye and Face Protection*, and provide basic protection against impact particles and innocuous sprays are Class I. Glasses and frames with side shields are the most common eye protection.
- Class II. Class II provides additional eye and face protection from impact particles. Class II protection consists of safety glasses with side shields worn below a full-face shield.

- Class III. Class III provides eye and face protection against chemical dusts, liquids, and gases. Class III protection consists of chemical goggles worn below a full-face shield.
- Class IV. This final class of equipment provides eye and face protection against special hazards encountered with furnace operations, welding, glasswork, laser operations, etc.

Ear Protection

The basic requirements for an ear protection program should include

- the need to maintain a hearing conservation program that consists of workplace monitoring for noise including
  - audiometric testing for employees who work in high-noise areas,
  - providing hearing protection equipment for employees,
  - records keeping,
  - training;
- the need to post high-noise areas appropriately and control access to such areas. Personnel shall not be allowed to enter high-noise areas without
  - appropriate hearing protection,
  - training in hearing conservation procedures,
  - a current (within 12 months) audiogram if entering a high-noise area is routine.

Protective Clothing

Proper protective clothing is required whenever hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered are capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact. The type of protective clothing to be used is based on the type of environment and hazards associated with the hazard.

Factors that affect the choice of protective clothing are permeability, durability and breakthrough.

Respiratory Protection

When engineering and administrative controls have been applied and the potential for airborne exposure still exists, respiratory protection should be used to limit exposures. Respiratory requirements for specific jobs are determined by the nature of the hazard and the work place conditions. Workers must be trained and qualified to use the prescribed protection. Additionally, workers must be fitted for the equipment to ensure the equipment functions properly. The two basic types of respirators are those which supply safe, clean air (atmospheric supplying) and those which purify the air (air purifying). Air purifying respirators have a limited life depending on the concentration of the contaminant in air, the type of canister, the ambient temperature and the wearer's breathing rate. An assigned protection factor is a factor of safety (X) in which a person may enter an atmosphere containing (X) times the acceptable concentration. A half-face respirator generally provides a protection factor of 10X. All respirators sold in the USA for industrial use are approved/certified by NIOSH/MSHA. OSHA requires that respirators used for employee protection must be certified or approved.

References: 10 CFR 850, “Chronic Beryllium Disease Prevention Program (CBDPP)”
10 CFR 851, “Worker Safety and Health Program; Proposed Rule”
29 CFR 1910, Subpart G, “Occupational Health and Environmental Control”
29 CFR 1910, Subpart Z, “Toxic and Hazardous Substances which includes the Hazard Communication standard.”
29 CFR 1910.1030, “Bloodborne pathogens”
29 CFR 1926, “Safety and Health Regulations for Construction”
42 CFR 72, “Interstate Shipment of Etiologic Agents”
42 CFR 73, “Possession, Use, and Transfer of Select Agents and Toxins”
ANSI Standard Z87, *American National Standard Practice for Occupational and Educational Eye and Face Protection*
ANSI Z41.1, *American National Standard for Personal Protection-Protective Footwear*
ANSI Z89.1-1986, *National Standard for Personnel Protection-Protective Headwear for Industrial Workers-Requirements*
Centers for Disease Control and Prevention Publication, *Biosafety in Microbiological and Biomedical Laboratories*
DOE O 440.1B, *Worker Protection Management*
DOE Order 5480.10, *Industrial Hygiene Program*
DOE Notice 450.7, *The Safe Handling, Transfer, and Receipt of Biological Etiologic Agents at Department of Energy Facilities*
DOE-STD-6005-2001, *Industrial Hygiene Practices*
National Institute of Health publication, *Guidelines for Research Involving Recombinant DNA Molecules*

17. Personnel shall demonstrate a familiarity level knowledge of DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities, and the principles of conduct of operations and relate these principles to an operational environment.

a. Discuss the purpose of DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities.

The purpose of DOE Order 5480.19 is to provide requirements and guidelines for Departmental Elements, including the National Nuclear Security Administration (NNSA), to use in developing directives, plans, and/or procedures relating to the conduct of operations at DOE facilities. The implementation of these requirements and guidelines should result in improved quality and uniformity of operations.

b. State the eighteen chapters in attachment 1 of DOE Order 5480.19, and discuss how each chapter contributes to an effective and safe operational environment.

Chapter 1 – Operations Organization and Administration

This chapter describes the administrative controls and practices that, when implemented fully, result in an effective and safe operational environment. This chapter includes DOE facility policies that describe the standards of excellence for facility operation and establish lines of responsibility for normal and emergency conditions. The following principles are suggested for the control of operations:

- Establishing written standards for operations
- Providing adequate resources to permit effective implementation
- Periodically monitoring and assessing performance
- Holding personnel accountable for their performance

Good practices for operations organization and administration are contained in DOE-STD-1032-92, Guide to Good Practices for Operations Organization and Administration.

Chapter 2 – Shift Routines and Operating Practices

This chapter describes some important aspects of routine shift activities and watch-standing practices that promote the professional conduct of operations personnel and result in meeting DOE and facility management expectations for operator performance. Professional conduct and good watch-standing practices result in appropriate attention to facility conditions, a necessary part of maintaining a safe and effective operational environment. Key elements are

- effective equipment monitoring to detect abnormal conditions or adverse trends;
- notifying supervisors promptly of unusual or unexpected situations;
- understanding equipment status and operational authority, and following proper industrial safety, radiological protection (if applicable), and quality assurance practices.

The chapter specifically provides guidelines for status practices, safety practices, operator inspection tours, use of round/tour inspection sheets, personnel protection, response to indications, resetting protective devices, load changes, authority to operate equipment, shift operating bases, and potentially distractive written material and devices.

Good practices for shift routines and operating practices are contained in DOE-STD-1041-93, *Guide to Good Practices for Shift Routines and Operating Practices*.

Chapter 3 – Control Area Activities

This chapter recognizes the control area or control room as the most critical facility operating base and the coordination point for all important facility activities. It stresses principles involving limited control area access, professional behavior of personnel in the control area, monitoring of main control panels, control operator ancillary duties, and operation of control area equipment. The chapter also addresses errors and unnoticed equipment problems if formality and attention to detail are not practiced by operators in the control room.

Good practices for control area activities are contained in DOE-STD-1042-93, *Guide to Good Practices for Control Area Activities.*

Chapter 4 – Communications

This chapter describes the important aspects of a plant program for audible communications and emphasizes that accurate communications are essential for the safe and efficient operation of facilities. Audible communications are used to transmit operating and emergency information in the facility. Examples are oral, telephone, radio, and public address announcements; sound-powered phones; and special sounds. Guidance provided includes the practice of repeating back instructions to ensure accurate transmission and receipt of verbal instructions, use of standardized terminology, and use of a phonetic alphabet. Inadequate communication is a common root cause behind operator error.

Good practices for communications are contained in DOE-STD-1031-92, *Guide to Good Practices for Communications.*

Chapter 5 – Control of On-Shift Training

The guidelines of this chapter relate to control of training activities by operations personnel. On-shift training should be conducted so that the trainee completes all of the required training objectives satisfactorily and receives maximum learning benefit from this experience without unduly affecting normal operations. Facility operation by personnel under instruction should be carefully supervised and controlled to avoid mistakes in operations by unqualified personnel and to use trainees' time effectively. These controls are therefore necessary to maintain safe and efficient operation of the facility during the conduct of hands-on training.

The following are important elements:

- Adherence to formal training programs
- Use of instructors that are qualified themselves on the subject equipment
- Supervision and control of trainees by qualified operators
- Operator qualification program approval
- Formal training documentation

Good practices for on-shift training are contained in DOE-STD-1040-93, *Guide to Good Practices for Control of On-Shift Training.*

Chapter 6 – Investigation of Abnormal Events

This chapter covers important aspects of the abnormal event investigation program. Abnormal events do occur and when they do, they often cause an impact on the safe and efficient operation of the affected facilities. Therefore, a program for the investigation of abnormal events should ensure that facility events are thoroughly investigated to assess the impact of the event, to determine the root cause of the event, to ascertain whether the event is reportable to DOE, and to identify corrective actions to prevent recurrence of the event. As future events are prevented through successful implementation of this program, the safe and efficient operation of the facility is improved.

Good practices for investigation of abnormal events is contained in DOE-STD-1045-93, *Guide to Good Practices for Notifications and Investigation of Abnormal Events.*

Chapter 7 – Notification

This chapter provides guidelines to ensure uniformity, efficiency, and thoroughness of notifications that support fulfillment of DOE requirements consistent with DOE O 232.1A, *Occurrence Reporting and Processing of Operations Information*. Proper notifications of abnormal or unusual events contribute to safe and efficient operation of the facility in a couple of ways. The first is that the notification results in the involvement of a larger pool of people whose knowledge can help stabilize and resolve the immediate situation at hand. The second is that being trained to follow a rigorous notification process ensures that vital information, needed to analyze and prevent future recurrence, is not overlooked.

Good practices for notifications are contained in DOE-STD-1045-93, *Guide to Good Practices for Notifications and Investigation of Abnormal Events.*

Chapter 8 – Control of Equipment and System Status

This chapter provides an overall perspective on control of equipment and system status. Control of equipment and system status contributes to safe and efficient facility operations by ensuring that an adequate safety envelope exists to authorize and perform work. A facility's safety envelope is defined by the proper operation and configuration of a set of equipment considered vital to a safe operating environment. This equipment is termed "vital safety equipment." If a piece of equipment fails or is shut down for maintenance, this fact needs to be recorded so that affected operations can be terminated or prevented until the equipment or system is restored. In the case where redundant equipment exists that could be operated to maintain the safety envelope for continued operations, its status must be known in order for it to be relied upon. Temporary modifications must also be tracked for the same reasons.

Good practices for control of equipment and system status are contained in DOE-STD-1039-93, *Guide to Good Practices for Control of Equipment and System Status.*

Chapter 9 – Lockouts and Tagouts

This chapter describes the important elements of a lockout/tagout program and is intended to meet the requirements of 29 CFR 1910, "Occupational Safety and Health Standards." A safe and efficient operational environment is maintained by providing a method for equipment status control through component tagging or locking that should protect personnel from injury, protect equipment from damage, maintain operability of plant systems, and maintain the integrity of the physical boundaries of plant systems. Appropriate and proper use of tags and locks prevents inadvertent operation of equipment when there is a potential for equipment damage or personnel injury during equipment operation, servicing, maintenance, or modification activities.

Good practices are contained in DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts.*

Chapter 10 – Independent Verification

This chapter describes the important aspects of an independent verification program that when implemented should provide a high degree of reliability in ensuring the correct facility operation and the correct position of components such as valves, switches, and circuit breakers. This is important to the safe and efficient operation of a facility because independent verification recognizes the human element of component operation; that is, any operator, no matter how proficient, can make a mistake. Thus, when mistakes are found and corrected before an operation takes place, safety and efficiency are improved.

Good practices are contained in DOE-STD-1036-93*, Guide to Good Practices for Independent Verification.*

Chapter 11 – Logkeeping

This chapter describes the features needed in the operation logs to ensure they are properly maintained. Operations logs should be established for all key shift positions and should contain a narrative of the facility's status and all events as required to provide an accurate history of facility operations. Proper log keeping is essential to the safe and efficient operation of a facility because it provides the data necessary for the reconstruction of abnormal or unusual events. When the data is properly analyzed and corrective actions are taken, subsequent recurrence of the event should be prevented. Logkeeping also promotes personal accountability and improved communication of information about the facility's status among operating personnel.

Good practices are contained in DOE-STD-1035-93, *Guide to Good Practices for Logkeeping.*

Chapter 12 – Operations Turnover

This chapter describes the important aspects of a good shift turnover. The comprehensive transfer of information pertinent to the operation of the facility is vital to safe and efficient operations, as evidenced by a historically high error rate associated with poor shift turnovers resulting from improper reviews of logs, unclear communications, and neglecting to discuss key operating parameters and status. Safe operations also depend on operating personnel being fit for duty. Therefore, it is also the responsibility of the off-going person to determine this by looking for evidence of sickness with corresponding degradation of mental or physical ability to do the job due to the sickness itself and/or the effects of medication the person might be taking. Other compromising conditions such as drug and alcohol abuse should also be considered.

Good practices are contained in DOE-STD-1038-93, *Guide to Good Practices for Operations Turnover*.

Chapter 13 – Operations Aspects of Facility Chemistry and Unique Processes

This chapter describes the important aspects of operations involving chemistry and unique processes and their relationship to safe and efficient facility operation. Operational monitoring of facility chemistry or unique process data and parameters should ensure that parameters are properly maintained. Proper monitoring will identify problems before components or safety is adversely affected. Operating personnel must be knowledgeable about the chemicals and processes they are working with and depending upon so that they can detect and correct off-normal parameters in a timely manner.

Good practices are contained in DOE-STD-1037-93, *Guide to Good Practices for Operations Aspects of Unique Processes.*

Chapter 14 – Required Reading

This chapter describes an effective required-reading program. Such a program contributes to facility safety and efficiency by ensuring that appropriate individuals are made aware of important information that is related to job assignments. Procedure changes, equipment design changes, related industry and in-house operating experience information, and other information necessary to keep operations department personnel aware of current facility activities are examples of the kind of useful information that should be made available to keep operating personnel current.

Good practices are contained in DOE-STD-1033-92, *Guide to Good Practices for Operations and Administration Updates through Required Reading.*

Chapter 15 – Timely Orders to Operators

This chapter describes the key features of an effective operator orders program. This contributes to safe and efficient operation by providing a means for communicating current, short-term information and administrative instructions to operations personnel. This becomes necessary to accommodate the changing needs and requirements of DOE facility operations. For example, orders could include instructions on the need for and performance of specific evolutions or tests; orders could also include work priorities, announcements of policy information, and administrative information. Typical information includes special operations, administrative directions, special data-collection requirements, plotting process parameters, and other similar short-term matters.

Good practices are contained in DOE-STD-1034-93, *Guide to Good Practices for Timely Orders to Operators.*

Chapter 16 – Operations Procedures

This chapter describes the important aspects of operations procedure development and use. Operations procedures should provide appropriate direction to ensure that the facility is operated within its design basis and should be effectively used to support safe operation of the facility. When operations personnel adhere to the policy to follow approved, properly written procedures, their operational performance should always be consistent and safe.

Guidance for developing procedures is contained in DOE-STD-1029-92, *Writer's Guide for Technical Procedures.*

Chapter 17 – Operator Aid Postings

This chapter describes the important aspects of an operator aid program. Facility operator aids (information posted for personnel use) should provide information useful to operators in performing their duties and thus provide an important function in the safe operation of the facility, provided that they are kept current and do not conflict with any other controlled procedure or information. Examples are copies of procedures (portion or pages thereof), system drawings, handwritten notes, information tags, curves, and graphs.

Good practices are contained in DOE-STD-1043-93, *Guide to Good Practices for Operator Aid Postings.*

Chapter 18 – Equipment and Piping Labeling

This chapter describes the important aspects of a labeling program. A well-established and maintained equipment-labeling program should help ensure that facility personnel are able to positively identify equipment they operate. It will enhance training effectiveness, help reduce operator and maintenance errors resulting from incorrect identification of equipment, and reduce personnel radiation and other hazardous material exposure as operators spend less time identifying components.

Good practices are contained in DOE-STD-1044-93, *Guide to Good Practices for Equipment and Piping Labeling.*

c. Discuss how each of the following Orders contributes to an effective and safe operations environment:

- **DOE O 231.1A, Environment, Safety, and Health Reporting**
- **DOE O 433.1, Maintenance Management Program for DOE Nuclear Facilities**
- **DOE O 414.1C, Quality Assurance**

DOE O 231.1A

The objective of this Order is to ensure timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that the Department of Energy (DOE) and National Nuclear Security Administration (NNSA) are kept fully informed on a timely basis about events that could adversely affect the health and safety of the public or the workers, the environment, the intended purpose of DOE facilities, or the credibility of the Department.

Chapter 1, section C3 of DOE Order 5480.19 states that safety, environment, and operating goals should be used as a management tool for involving cognizant groups or individuals in improving operating performance and for measuring operating effectiveness.

DOE O 433.1

This order was superseded by DOE 433.1A.

The purpose of this Order is to define the safety management program required by 10 CFR 830.204(b)(5) for maintenance and the reliable performance of Structures, Systems and Components (SSCs) that are part of the safety basis required by 10 CFR 830.202.1 at hazard category 1, 2 and 3 Department of Energy (DOE) nuclear facilities.

Chapter 8, section C7 of DOE Order 5480.19 states that DOE facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing activities. Equipment should be tested following maintenance to demonstrate that it is capable of performing its intended function. The testing should include performance of all functions that may have been affected by the maintenance. The testing should also verify that the maintenance performed served to correct the original problem and that no new problems were introduced. Any testing following maintenance should be specified on the maintenance work order.

Chapter 9, section A of DOE Order 5480.19 states that the logout/tagout program should ensure that potentially hazardous energy or toxic material sources are isolated and rendered inoperative during servicing or maintenance or in any case where unexpected energizing, startup, or release of stored energy or toxic material can cause injury.

Chapter 13, section A of DOE Order 5480.19 states that operational monitoring of facility chemistry or unique recess data and parameters should ensure that parameters are properly maintained. Maintenance of proper processes will promote maximum component life.

Chapter 18, section B of DOE Order 5480.19 states that a good labeling program, understood and maintained by operating and maintenance personnel, will enhance training effectiveness and will help reduce operator and maintenance errors resulting from incorrect identification of equipment. Personnel radiation exposure or exposure to hazardous materials will also be reduced if operators spend less time identifying components.

DOE 414.1C

The purpose of DOE Order 5480.19 is to provide requirements and guidelines for Departmental elements to use in developing directives, plans, and/or procedures relating to the conduct of operations at DOE facilities. The implementation of these requirements and guidelines should result in improved quality and uniformity of operations.

Chapter 1, section C3 of DOE Order 5480.19 states that other groups, such as quality assurance personnel, should periodically review and assess operation performance. These reviews can assist line managers and supervisors in identifying and correcting problems.

d. Discuss proper critique principles and describe a proper critique process, including key elements.

The purpose of critiques is to assemble all of the facts about an event or operation. It is not to assign blame or to be used as a basis to administer disciplinary action against an involved employee. Employees must feel free to provide factual information without fear of retribution, and this must be communicated to them and practiced consistently by management for a cultural environment to exist that will support an effective critique process. Otherwise, information will be concealed that may be important to preventing recurrence of the event.

The principles and elements of a good critique process are as follows:

- Off-normal events and successes are critiqued. The critique of off-normal events provides the basis for understanding why something went wrong and how to prevent its recurrence. The critique of successes is to be able to repeat the success and to find ways of improving upon the success at the same time.
- The designation of who calls and conducts the critique meeting(s) is important to obtaining the facts in a complete and impartial manner. It may be necessary to assign a leader who was not involved in the event to prevent prejudice or inappropriate influence of the outcome.
- A critique is a formal meeting. It may consist of several meetings with a combination of personnel.
- All who can contribute factual information should attend the critique meeting(s).
- The DOE facility representative should be notified of each critique meeting and invited to attend.
- Critique meetings should, with few exceptions, be held as soon as the situation is stable. In any event, they are held before the involved people leave for the day, if possible. There are cases when an event is not discovered until sometime after those involved have gone home and they may get called back in, or those discovering the event may not know immediately everyone who might have factual knowledge.
- Initial categorization and notification for DOE O 232.1A, *Occurrence Reporting and Processing of Operations Information,* is made before or concurrently with the

critique meeting. DOE O 232.1A, *Occurrence Reporting and Processing of Operations Information,* requires this to be done within 2 hours of discovery of the event's happening.

- A form is provided in the administrative procedure to be completed for the personal statements that are made by involved personnel.
- Before a critique convenes, the leader determines if personal statements are necessary. If they are, the leader will distribute forms to the appropriate people.
- When personal statements are required of key personnel involved with the event, they are encouraged to write what they did, saw, heard, etc.
- The statements are preferably prepared before the critique meeting starts and before the principal, involved people get together to discuss the event. Collaboration of the people involved greatly reduces the value of the statements.
- Personal statements are signed and dated.
- Completed personal statements are provided to the leader at the critique meeting. They are attached to the meeting minutes and become part of the official record.
- Formal meeting minutes are recorded. Facts shall be listed in chronological order. Tape recorders, stenographers, etc., are used to help document the minutes.
- The leader and all contributors sign critique minutes.
- A pre-designed form helps to guide the leader through the critique process. It provides the line of questioning and includes places for the pertinent information. The form is provided in the administrative procedure.
- Critique minutes serve as the record of what happened for simple events and the foundation for any subsequent investigation, if warranted, for more complex events. Categorization and/or notification may be changed when the critique is completed.
- Critique minutes facilitate the assigning of corrective action(s) and provide the basis from which the root cause and recurrence control can be determined.
- Critique reports are distributed within the facility, to other selected facilities, to DOE, and to a central organization for the purposes of further distribution and analysis.
- Persons designated as critique leaders are formally trained for the task and have passed a written test and an oral examination.
- The critique leader must endeavor to fully understand the details, corroborate the facts, challenge assumptions, and be aware of what hasn't been established (look for holes and missing information).

e. Define the term "root cause" and explain its importance to operational safety.

The root cause is defined as the basic reason(s) for or the fundamental cause of an event, which if corrected, will prevent recurrence. Operational failures of all kinds (operator error, component failure, management system failure, procedural error, etc.) challenge the safety environment of a facility. Therefore, any reduction in the incident rate and/or the severity of off-normal events will result in an overall improvement of safety for the workers and the public at large.

Correctly identifying the root cause with corresponding corrective actions has the direct effect of achieving such a reduction.

f. Define the term “lessons learned” and explain their importance in operational safety.

Lessons learned are bulletins that contain related industry (e.g., NRC, commercial nuclear, etc.) and in-house (i.e., within DOE) operating experience information that may be of interest to operating personnel and management with respect to preventing off-normal events and/or improving operational efficiency. They come from a variety of sources, such as the occurrence reporting and processing system database, the weekly operating experience summary from the DOE Office of Nuclear Safety, and Government-Industry Data Exchange Program on-line information retrieval.

Lessons learned information contributes to operational safety by preventing future similar operational events from occurring, improving techniques for performing operations such that a risk reduction occurs, and improving management control systems that affect safety to make them more comprehensive or to correct deficiencies.

DOE maintains a Lessons Learned database on web page: http://www.eh.doe.gov/doell.

g. Describe stop work authority and the role of personnel in its application.

All personnel whether they are contractor employees, subcontractors, visitors, or students have the authority and responsibility to stop work after identifying a hazardous condition or a condition that is adverse to quality in the work place.

Personnel who discover a condition that is believed to warrant a stop-work action may not be in a position to understand how to safely stop work. In some cases, abruptly stopping an activity could create a greater hazard. For this reason, personnel involved in an unsafe activity or a condition that is adverse to quality must involve their supervisor in the stop-work action. Since additional requirements may apply to situations involving stop-work actions, workers and supervisors shall determine the possible need for lockout/tagout processes, revisions of safety plans, formal readiness reviews, occurrence reporting, etc.

h. Describe the key elements of a lockout/tagout system.

A tagout system includes the placement of a tagout device on an energy-isolating device, in accordance with an established procedure, to indicate that the energy-operating device and the equipment being controlled many not be operated until the tagout device is removed. Similarly, a lockout system includes the placement of a lockout device (e.g., a lock, or hasp with a lock in place) on an energy-isolating device in accordance with an established procedure ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the Lockout device is removed. An effective lockout/tagout system should be developed by each facility and should include detailed administrative procedures, training of personnel, and uniquely identifiable tags. The system should also exercise appropriate control over lockout/tagout preparation, approval, placement, and removal; provide for adequate documentation; and be consistent with the requirements of 29 CFR 1910.

References: DOE G 231.1-2, *Occurrence Reporting Causal Analysis Guide*

DOE O 232.1A, *Occurrence Reporting and Processing of Operations Information*
DOE O 433.1, *Maintenance Management Program for DOE Nuclear Facilities*
DOE O 414.1C, *Quality Assurance*
DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*
DOE-STD-1029-92, *Writer's Guide for Technical Procedures*
DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*
DOE-STD-1031-92, *Guide to Good Practices for Communications*
DOE-STD-1032-92, *Guide to Good Practices for Operations Organization and Administration*
DOE-STD-1033-92, *Guide to Good Practices for Operations and Administration Updates through Required Reading*
DOE-STD-1034-93, *Guide to Good Practices for Timely Orders to Operators*
DOE-STD-1035-93, *Guide to Good Practices for Logkeeping*
DOE-STD-1036-93, *Guide to Good Practices for Independent Verification*
DOE-STD-1038-93, *Guide to Good Practices for Operations Turnover*
DOE-STD-1039-93, *Guide to Good Practices for Control of Equipment and System Status*
DOE-STD-1040-93, *Guide to Good Practices for Control of On-Shift Training*
DOE-STD-1041-93, *Guide to Good Practices for Shift Routines and Operating Practices*
DOE-STD-1042-93, *Guide to Good Practices for Control Area Activities*
DOE-STD-1044-93, *Guide to Good Practices for Equipment and Piping Labeling*
DOE-STD-1045-93, *Guide to Good Practices for Notifications and Investigation of Abnormal Events*

18. Personnel shall demonstrate a familiarity level knowledge of DOE O 231.1A, Environment, Safety, and Health Reporting, and DOE M 231.1-2, Occurrence Reporting and Processing of Operations Information.

a. State the purpose of DOE O 231.1A, Environment, Safety and Health Reporting.

The purpose of DOE 231.1A is to ensure timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed to ensure that the Department of Energy (DOE) and National Nuclear Security Administration (NNSA) are kept fully informed on a timely basis about events that could adversely affect the health and safety of the public or the workers, the environment, the intended purpose of DOE facilities, or the credibility of the Department.

Several manuals and guides provide detailed requirements/guidance to supplement DOE Order 231.1A including the following:

- DOE M 231.1-1A, *Environment, Safety, and Health Reporting*
- DOE M 231.1-2, *Occurrence Reporting and Processing Operations Information*

- DOE G 231.1-1, *Occurrence Reporting Performance Analysis and Reporting Guide*
- DOE G 231.1-2, *Occurrence Reporting Causal Analysis Guide*

b. Define the following terms:

- **Event**
- **Condition**
- **Notification report**
- **Occurrence report**
- **Reportable occurrence**
- **Facility Representative**

The following information is taken from DOE M 232.1-2, *Occurrence Reporting and Processing of Operations Information.*

Event

Something significant and real-time that happens (e.g., pipe break, valve failure, loss of power, environmental spill, earthquake, tornado, flood).

Condition

Any as-found state, whether or not resulting from an event, that may have adverse safety, health, quality assurance, operational or environmental implications. A condition is usually programmatic in nature; for example, errors in analysis or calculation; anomalies associated with design or performance; or items indicating a weakness in the management process are all conditions.

Facility

Any equipment, structure, system, process, or activity that fulfills a specific purpose. Examples include accelerators, storage areas, fusion research devices, nuclear reactors, production or processing plants, coal conversion plants, magnetohydrodynamic experiments, windmills, radioactive waste disposal systems and burial grounds, environmental restoration activities, testing laboratories, research laboratories, transportation activities, and accommodations for analytical examinations of irradiated and unirradiated components.

Notification Report

The initial documented report, to the Department, of an event or condition that meets the reporting criteria defined in DOE M 232.1-2.

Occurrence Report

A documented evaluation of an event or condition that is prepared in sufficient detail to enable the reader to assess its significance, consequences, or implications and to evaluate the actions being proposed or employed to correct the condition or to avoid recurrence.

Reportable Occurrence

Occurrence to be reported in accordance with the criteria defined in DOE M 232.1-2.

Facility Representative

For each major facility or group of lesser facilities, an individual or designee assigned responsibility by the Head of Field Element/Operations Organization (including NNSA) for monitoring the performance of the facility and its operations. This individual should be the primary point of contact with the facility operating personnel and will be responsible to the appropriate Secretarial Officer/Deputy Administrator (NNSA) and Head of Field Element/Operations Organization for implementing the requirements of this Manual.

c. Discuss the occurrence-reporting responsibilities of a facility representative.

Facility Representatives are responsible for the following:

- Evaluating facility implementation of the notification and reporting process to ensure it is compatible with and meets the requirements of DOE M 232.1-2
- Maintaining day-to-day operational oversight of contractor activities, as described in DOE-STD-1063-2003, *Facility Representatives*
- Ensuring that occurrences that may have generic or programmatic implications are identified and elevated to the Head of the Field Element for appropriate action
- Ensuring that facility personnel act to minimize and prevent recurrence of significant events
- Reviewing and assessing reportable occurrence information from facilities under their cognizance to determine the acceptability of the Facility Manager's evaluation of the significance, causes, generic implications, and corrective action implementation and closeout, and to ensure that facility personnel involved in these operations perform the related functions
- Ensuring that Occurrence Reports are prepared and transmitted in accordance with DOE information security requirements
- Interacting with facility personnel and field element oversight organizations as necessary and informing and advising their respective managements of their findings
- Elevating any unresolved issues regarding actions or determinations on a reportable occurrence to the Program Manager for resolution and direction
- Being available at all times to satisfy the requirements of DOE M 232.1-2

d. State the different categories of reportable occurrences and discuss each.

The categories are

- Operational emergencies
- Significance category 1
- Significance category R
- Significance category 2
- Significance category 3
- Significance category 4

Operational Emergencies (OEs)

Operational Emergency Occurrences are the most serious occurrences and require an increased alert status for onsite personnel and, in specified cases, for offsite authorities.

Significance Category 1

Occurrences that are not Operational Emergencies and that have a significant impact on safe facility operations, worker or public safety and health, regulatory compliance, or public/business interests.

Significance Category R

Occurrences that are identified as recurring, as determined from the periodic performance analysis of occurrences across a site.

Significance Category 2

Occurrences that are not Operational Emergencies and that have a moderate impact on safe facility operations, worker or public safety and health, regulatory compliance, or public/business interests.

Significance Category 3

Occurrences that are not Operational Emergencies and that have a minor impact on safe facility operations, worker or public safety and health, regulatory compliance, or public/business interests.

Significance Category 4

Occurrences that are not Operational Emergencies and that have some impact on safe facility operations, worker or public safety and health, or public/business interests.

DOE maintains an Occurrence Reporting and Processing System (ORPS) data base on web page: https://orps.tis.eh.doe.gov/do/june2005.html.

e. State the major criteria groups of categorized occurrences and discuss each.

Groups of reportable occurrences

The Order also identifies 10 Groups of reportable occurrences:

- Group 1 – Operational emergencies
- Group 2 – Personnel safety
- Group 3 – Nuclear safety basis
- Group 4 – Facility status
- Group 5 – Environmental
- Group 6 – Contamination/radiation control
- Group 7 – Nuclear explosive safety
- Group 8 – Transportation
- Group 9 – Noncompliance notifications
- Group 10 – Management concerns/issues

Group 1 – Operational Emergencies

- An operational emergency not needing further classification
- An alert
- A site area emergency
- A general emergency

Group 2 – Personnel Safety

Subgroup A – Occupational Illness/Injury

- Any occurrence due to DOE operations resulting in a fatality or terminal injury/illness. For fatalities caused by overexposures, the intent of this criterion is to report those caused by acute rather than chronic effects.
- Any single occurrence requiring in-patient hospitalization of three or more personnel.
- Any single occurrence resulting in three or more personnel having days away, restricted or transferred cases per 29 CFR Part 1904.7.

Subgroup B – Fires/Explosions

- Any unplanned fire or explosion within primary confinement/containment boundaries for nuclear or hazardous material within a facility.
- Any unplanned fire or explosion in a non-nuclear facility that
  - activates a fire suppression system,
  - takes longer than 10 minutes to extinguish following the arrival of fire protection personnel, or
  - disrupts normal operations in a high hazard facility.

Subgroup C – Hazardous Energy Control

- Failure to follow a prescribed hazardous energy control process (e.g., lockout/tagout) or disturbance of a previously unknown or mislocated hazardous energy source (e.g., live electrical power circuit, steam line, pressurized gas) resulting in a person contacting (burn, shock, etc.) hazardous energy

Group 3 – Nuclear Safety Basis

- Technical safety requirement violations
- Documented safety analysis inadequacies
- Nuclear criticality safety

Group 4 – Facility status

- Safety system/structure/component degradation
- Operations
- Suspect or counterfeit items

Group 5 – Environmental

- Releases
- Ecological and cultural resources

Group 6 – Contamination/radiation control

- Loss of control of radioactive material
- Spread of Radioactive Contamination
- Radiation Exposure
- Personnel contamination

Group 7 – Nuclear explosive safety

- Damage to a nuclear explosive that results in a credible threat to nuclear explosive safety

- A violation of a nuclear explosive safety rule (NESR)
- The unauthorized compromise of a nuclear explosive safety feature when installed on a nuclear explosive
- Inadvertent substitution of a nuclear explosive for a nuclear explosive-like assembly (NELA) or vice versa
- Damage to a training unit during training operations indicative of a hazard to a nuclear explosive
- The use of uncertified personnel or unauthorized equipment/tooling during a nuclear explosive operation
- A violation of the two-person concept of operations
- Revocation of the Personnel Assurance Program certification of an individual (for cause)

Group 8 – Transportation

- Any offsite transportation incident involving hazardous materials that would require immediate notice pursuant to 49 CFR Part 171.15, (e.g., when a person is killed or receives injuries requiring hospitalization)
- Any offsite transport of hazardous material, including radioactive material, whose quantity or nature (e.g., physical or chemical composition) is different than intended

Group 9 – Noncompliance notifications

- Any enforcement action (other than associated with the Price Anderson Amendment Act) involving 10 or more cited violations, and/or an assessed fine of $10,000 or more
- Any written notification from an outside regulatory agency that a site/facility is considered to be in noncompliance with a schedule or requirement

Group 10 – Management concerns/issues

- Any event resulting in the initiation of a Type A or B accident investigation as categorized by DOE O 225.1A, *Accident Investigation*
- An event, condition, or series of events that does not meet any of the other reporting criteria, but is determined by the Facility Manager or line management to be of safety significance or of concern to other facilities or activities in the DOE complex
- A near miss, where no barrier or only one barrier prevented an event from having a reportable consequence

References: 10 CFR 835, “Occupational Radiation Protection”
29 CFR 1904, “Recording and Reporting Occupational Injuries and Illnesses”
40 CFR 302, “Designation, Reportable Quantities, and Notification”
40 CFR 355, “Emergency Planning and Notification”
DOE G 231.1-1, *Occurrence Reporting Performance Analysis and Reporting Guide*
DOE G 231.1-2, *Occurrence Reporting Causal Analysis Guide*
DOE M 231.1-1A, *Environment, Safety, and Health Reporting*
DOE M 231.1-2, *Occurrence Reporting and Processing Operations Information*

DOE O 151.1C, *Comprehensive Emergency Management System*
DOE O 225.1A, *Accident Investigation*
DOE O 231.1A, *Environment, Safety, and Health Reporting*

19. Personnel shall demonstrate a familiarity level knowledge of 10 CFR 830 Subpart A, Quality Assurance and DOE O 414.1C, Quality Assurance.

a. Discuss the objectives and applicability of the DOE quality requirements, including the relationship between 10 CFR 830 Subpart A and DOE O 414.1C, and the relationship between DOE quality requirements and American National Standard ASME NQA-1 for nuclear facility applications.

Objectives

- To ensure that quality of DOE and NNSA products and services meet or exceed customers' expectations
- To achieve quality assurance (QA) for all work based upon the following principles:
  - That quality is assured and maintained through a single, integrated, effective quality assurance program (i.e., management system)
  - That management support for planning, organization, resources, direction, and control is essential to QA
  - That performance and quality improvement require thorough, rigorous assessment and corrective action
  - That workers are responsible for achieving and maintaining quality
  - That environmental, safety, and health risks and impacts associated with work processes can be minimized while maximizing reliability and performance of work products
- To establish quality process requirements to be implemented under a QA Program (QAP) for the control of suspect/counterfeit items and safety issue corrective actions

Applicability

DOE/NNSA Elements

DOE elements, including NNSA (excepting the Naval Reactors Program and the Bonneville Power Administration) must follow this Order when performing their work.

Contractors

DOE O 414.1C is implemented by contractors through their Contractor Requirements Documents (CRDs). The CRD must be included in contracts addressing work or operation at DOE sites, facilities, or for work accomplished outside of DOE physical boundaries, such as design, analytical, or other support-related services.

CRDs are incorporated into DOE contracts to ensure contractor compliance with the Order.

Note: When DOE Orders are revised, they are not immediately incorporated into the contract. Rather there is some time period for incorporating the new Order requirements (and then a given time period for implementing the new requirements).

Relationship to 10 CFR 820

DOE O 414.1C serves as an implementation Order for the QA Program requirements as identified in the 10 CFR 830 Federal regulation.

Relationship to ASME NQA-1

This standard reflects industry experience and current understanding of the quality assurance requirements necessary to achieve safe, reliable, and efficient utilization of nuclear energy, and management and processing of radioactive materials. The standard focuses on the achievement of results, emphasizes the role of the individual and line management in the achievement of quality, and fosters the application of these requirements in a manner consistent with the relative importance of the item or activity.

b. Discuss 10 CFR 830.4, General Requirements, 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Requirements, including the Federal responsibilities and applicability of the requirements to DOE and its contractors.

10 CFR 830.4

General requirements

- No person may take or cause to be taken any action inconsistent with the requirements of this part.
- A contractor responsible for a nuclear facility must ensure implementation of, and compliance with, the requirements of this part.
- The requirements of this part must be implemented in a manner that provides reasonable assurance of adequate protection of workers, the public, and the environment from adverse consequences, taking into account the work to be performed and the associated hazards.
- If there is no contractor for a DOE nuclear facility, DOE must ensure implementation of, and compliance with, the requirements of this part.

10 CFR 830, Subpart A

This subpart establishes quality assurance requirements for contractors conducting activities, including providing items or services that affect, or may affect, nuclear safety of DOE nuclear facilities.

DOE O 414.1C

Quality Assurance Program (QAP) Requirements

Each DOE organization must develop and implement a QAP that does the following:

- Implements QA criteria using a graded approach and describing how the criteria and graded approach are applied
- Uses national or international consensus standards where practicable and consistent with contractual or regulatory requirements (e.g., 10 CFR 830) and identifies the standards used. Appropriate standards include the following:
    - ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications (for nuclear-related activities)*
    - ANSI/ISO/ASQ Q 9001-2000, *Quality Management System: Requirements (for nonnuclear activities)*

- ANSI/ASQ Z 1.13, *Quality Guidelines for Research, 1999 (for nonnuclear research activities)*

- Applies additional standards, where practicable and consistent with contractual or regulatory requirements and as necessary to address unique/specific work activities (e.g., development and use of safety software or establishing the competence of a testing and calibration laboratory) [Note: These standards are sometimes referred to as "voluntary standards." However, once a practicable standard(s) is adopted through regulation, code, contract, QAP, or procedure, compliance with the standard is required and is not voluntary.]
- Integrates, where practicable and consistent with contract or regulatory requirements, quality management system requirements as defined in this Order, the S/CI prevention process, the Corrective Action Management Program, and Safety Software Quality Requirements with other quality or management system requirements in DOE directives and external requirements, including, as applicable,
  - DOE P 450.4, *Safety Management System Policy*, dated 10-15-96
  - DOE P 450.5, *Line Environment, Safety and Health Oversight*, dated 06-26-97
  - NNSA Quality Management Policy, QC-1, (Quality Management System for the Nuclear Weapons Complex and Weapons-Related Activities)
  - DOE/RW-0333P, DOE Office of Civilian Radioactive Waste Management, *Quality Assurance Requirements and Description*
  - DOE/CBFO-94-1012, DOE Carlsbad Field Office, *Quality Assurance Program Description, (for the Waste Isolation Pilot Plant and related activities)*

c. Describe, in general terms, the content and objectives of the quality assurance criteria in the following categories, as found in DOE O 414.1C:
- **Management**
- **Performance**
- **Assessment**

Section I: Management

Criterion 1–Program
- The QAP must describe the organizational structure, functional responsibilities, levels of authority, and interfaces for those managing, performing, and assessing the work.
- The QAP must describe management processes, including planning, scheduling, and resource considerations.

The principal measure of an organization's performance is the quality of its products and services. The QA Order and Rule require that an organization develop, document, and maintain an effective QAP, also referred to as a quality management system. The goal of the quality management system is delivery of safe, reliable products and services that meet or exceed the customer's requirements, needs, and expectations.

Criterion 2–Personnel Training and Qualification
- Personnel must be trained and qualified to ensure they are capable of performing their assigned work.
- Personnel must be provided continuing training to ensure that job proficiency is maintained.

Policies and procedures that describe personnel selection, training, and qualification requirements should be established for each function.

Training assists personnel in acquiring knowledge of the correct and current processes and methods to accomplish assigned tasks. It enables personnel to understand the fundamentals of the work, the associated hazards**,** the context within which the work is performed, and the reasons for any special work requirements. Initial training should prepare personnel to perform the job. Continuing training should maintain and promote improved job performance.

Before personnel are allowed to work independently, management should ensure those personnel have the necessary experience, knowledge, skills, and abilities.

Criterion 3–Quality Improvement

- Processes to detect and prevent quality problems must be established and implemented.
- Items, services, and processes that do not meet established requirements must be identified, controlled, and corrected in accordance with established requirements.
- Corrective Action Plans must include identifying the causes of problems and working to prevent recurrence.
- Item characteristics, process implementation, and other quality-related information must be reviewed and the data analyzed to identify items, services, and processes needing improvement.

Quality improvement is a disciplined management process based on the premise that all work can be planned, performed, measured, and improved. Management should ensure that the focus is on improving the quality of products, processes, and services by establishing priorities, promulgating policy, promoting cultural aspects, allocating resources, communicating lessons learned, and resolving significant management issues and problems that hinder the organization from achieving its objectives. Management should balance safety and mission priorities (SMS Policy Principle 4) when considering improvement actions.

Criterion 4–Documents and Records

- Documents must be prepared, reviewed, approved, issued, used, and revised to prescribe processes, specify requirements, or establish design.
- Records must be specified, prepared, reviewed, approved, and maintained.

Key points

- A document system must be established and implemented.
- Measures should be implanted to make sure that only correct documents are in use.
- Records should accurately reflect completed work and be carefully maintained.

Section II: Performance

Criterion 5–Work Processes

- Work must be performed consistent with technical standards, administrative controls, and hazard controls adopted to meet regulatory or contractual requirements using approved instructions, procedures, or other appropriate means.

- Items must be identified and controlled to ensure their proper use.
- Items must be maintained to prevent their damage, loss, or deterioration.
- Equipment used for process monitoring or data collection must be calibrated and maintained.

Work is defined as the process of performing a defined task or activity. Work processes consist of a series of actions planned and carried out by qualified personnel using approved procedures, instructions, and equipment under administrative, technical, and environmental controls to achieve an end result.

Criterion 6–Design

- Items and processes must be designed using sound engineering/scientific principles and appropriate standards.
- Applicable requirements and design bases must be incorporated into design work and changes.
- Design interfaces must be identified and controlled.
- The adequacy of design products must be verified or validated by individuals or groups other than those performing the work.
- Verification and validation of work must be completed before approval and implementation of the design.

A design process should be established that provides appropriate control of design inputs, outputs, verification, configuration and design changes, and technical and administrative interfaces. Design work should be based on sound engineering judgment, scientific principles, and applicable codes and standards. DOE O 420.1, *Facility Safety*, identifies some of the design requirements.

Criterion 7–Procurement

- Procured items and services must meet established requirements and perform as specified.
- Prospective suppliers must be evaluated and selected on the basis of specified criteria.
- Processes must be established and implemented to ensure that approved suppliers continue to provide acceptable items and services must be established and implemented.

The procurement process should ensure that items and/or services provided by suppliers meet the requirements and expectations of the end user. The procurement process should be planned and controlled to ensure that

- the end user's requirements are accurately, completely, and clearly communicated to the supplier;
- supplier, designer, and end-user requirements are met during the production phase;
- the proper product is delivered on time and maintained until use.

Criterion 8–Inspection and Acceptance Testing

- Inspection and testing of specified items, services, and processes must be conducted using established acceptance and performance criteria.
- Equipment used for inspections and tests must be calibrated and maintained.

Inspections and tests are accomplished to verify that physical and functional aspects of items, services, and processes meet requirements and are fit for acceptance and use. Performance expectations, inspections and tests should be identified/considered early in the design process and/or specified in the design output and procurement documents.

Section III: Assessment

Criterion 9–Management Assessment

Managers must assess their management processes to identify and correct problems that hinder the organization in achieving its objectives must be identified and corrected.

Managers at every level should periodically assess their organizations and functions to determine how well they meet customer and performance expectations and mission objectives, identify strengths or improvement opportunities, and correct problems. Assessments should address the effective use of resources to achieve the organization's goals and objectives. Management assessments should determine whether an integrated management system exists and whether it focuses on meeting both customer and performance requirements and strategic goals.

Criterion 10–Independent Assessment

- Independent assessments must be planned and conducted to measure item and service quality, to measure the adequacy of work performance, and to promote improvement.
- The group performing independent assessments must have sufficient authority and freedom from the line to carry out its responsibilities.
- Persons conducting independent assessments must be technically qualified and knowledgeable in the areas assessed.

Senior management should establish and implement a process to obtain an independent assessment of the organization's programs, projects, contractors, and suppliers. The purpose of this type of assessment is to evaluate compliance performance of work processes with regard to requirements, expectations of customers, and efforts required to achieve the mission and goals of the organization. The results of independent assessments provide an objective form of feedback to senior management that is useful in confirming acceptable performance and should be used for identifying improvement opportunities.

d. Discuss the quality requirements in the following attachments (and supporting implementing guides) of DOE O 414.1C, how the quality requirements become nuclear safety requirements for contractors, and how they apply to Federal organizations:

- **Attachment 3, Suspect/Counterfeit Items Prevention and the supporting guide, DOE G 414.1-3**
- **Attachment 4, Corrective Action Management Program, and the supporting guide, DOE G 414.1-5**
- **Attachment 5, Safety Software Quality Requirements, and the supporting guide, DOE G 414.1-4**

Safety Software Requirements—DOE G 414.1-4

The Department's objectives for safety software requirements include

- grading software quality assurance (SQA) requirements based on risk, safety, facility life-cycle, complexity, and project quality requirements;
- applying SQA requirements to software life-cycle phases;
- developing procurement controls for acquisition of computer software and hardware that are provided with supplier-developed software and/or firmware;
- documenting and tracking customer requirements;
- managing software configuration throughout the life-cycle phases;
- performing verification and validation processes;
- performing reviews of software configuration items, including reviewing the safety implications identified in the failure analysis and fault tolerance design; and
- training personnel who use and apply software in safety applications.

The scope of this guide includes software applications that meet safety software definitions as stated in DOE O 414.1C. This includes software applications important to safety that may be included or associated with structures, systems, or components (SSCs) for less than hazard category 3 facilities. Safety software includes safety system software, safety and hazard analysis software and design software, and safety management and administrative control software.

Safety system software is software for a nuclear facility that performs a safety function as part of an SSC and is cited in either (1) a DOE approved documented safety analysis or (2) an approved hazard analysis per DOE P 450.4, *Safety Management System Policy*, dated 10-15-96, and the DEAR clause.

Safety and hazard analysis software and design software is software that is used to classify, design, or analyze nuclear facilities. This software is not part of an SSC but helps to ensure the proper accident or hazards analysis of nuclear facilities or an SSC that performs a safety function.

Safety management and administrative controls software is software that performs a hazard control function in support of nuclear facility or radiological safety management programs or TSRs or other software that performs a control function necessary to provide adequate protection from nuclear facility or radiological hazards. This software supports eliminating, limiting, or mitigating nuclear hazards to workers, the public, or the environment as addressed in 10 CFR 830, 10 CFR 835, and the DEAR ISMS clause.

Although this guide has been developed for DOE nuclear facility software, it may also be useful for ensuring the quality of other software important to mission critical functions, environmental protection, health and safety protection, safeguards and security, emergency management, or assets protection.

Suspect/Counterfeit Items(S/CIs)—DOE G 414.1-3

DOE/NNSA is committed to effective controls for the prevention, detection, and disposition of S/CIs to mitigate any potential safety threat in the DOE/NNSA complex. In accordance with the requirements of DOE O 414.1C, the principal objectives of S/CI controls are as follows:

- Ensure that items intended for application in safety systems and mission critical facilities comply with design and procurement documents.

- Maintain current, accurate information on S/CIs and associated suppliers using all available sources within the Government and industry and disseminate relevant information on S/CIs to field organizations and contractors.
- Identify, control, and dispose of S/CIs that create potential hazards in safety systems and applications.
- Report discoveries of and disseminate information about S/CIs to field organizations, contractors, and government agencies.
- Train and inform managers, supervisors, and workers of S/CI controls and indicators, including prevention, detection, and disposition of S/CIs.

These controls should also include obtaining contractual remedies from suppliers of S/CIs.

Corrective Action Management Program—DOE G 414.1-5

The objective of the Corrective Action Management Program is to prescribe process requirements for DOE line managers to effectively perform corrective actions for safety issues arising from

- findings identified by the Offices of Independent Oversight and Performance Assurance; Environment, Safety, and Health (ES&H); and Emergency Management (DOE O 470.2B, *Independent Oversight and Performance Assurance Program*);
- judgment of needs identified by Type A accident investigations (DOE O 225.1A, *Accident Investigations*);
- findings identified by the Office of Aviation Management (DOE O 440.2B);
- other sources as directed by the Secretary or Deputy Secretary, including crosscutting safety issues.

The Order provides requirements for

- reporting findings;
- corrective action plan development, approval, and review;
- tracking and reporting;
- corrective action effectiveness review;
- identifying and reporting lessons learned;
- chartering and maintenance of the corrective action management team.

e. Describe the Federal responsibilities for review, approval, and oversight of contractor quality assurance programs developed under 10 CFR 830 and DOE O 414.1C.

Quality Assurance Program Approvals and Changes

The contractor must

- submit a QAP to DOE for approval before beginning work under a DOE contract;
- implement the QAP as approved and modified by DOE;
- indicate in the submittal any third-party certification affecting the QAP;
- revise an existing QAP that was approved in accordance with previous versions of the CRD to DOE O 414.1C, *Quality Assurance*, to address enhancements required by the CRD;
- regard a QAP as approved by DOE 90 calendar days after DOE receipt, unless approved or rejected by DOE at an earlier date, and include any modification made or directed by DOE;

- submit QAP changes made the previous year annually to DOE for review and approval. In the submittal, identify the changes, the reason for the changes, and the basis for concluding that the revised QAP continues to satisfy the requirements of the CRD.
- The contractor may make changes to an approved QAP at any time.
- Editorial changes made to correct spelling, punctuation, grammar, etc., do not require explanation.

References: 10 CFR 830.4, "General Requirements"
10 CFR 830.120, "Quality Assurance Requirements"
DOE G 414.1-2A, *Quality Assurance Management System Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*
DOE G 414.1-3, *Suspect/Counterfeit Items Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1B, Quality Assurance*
DOE G 414.1-4, *Safety Software Guide for Use with 10 CFR 830, Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*
DOE G 414.1-5, *Suspect/Counterfeit Items Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1B, Quality Assurance*
DOE O 225.1A, *Accident Investigations*
DOE O 414.1C, *Quality Assurance*
DOE O 440.2B, *Aviation Management and Safety*
DOE O 470.2B, *Independent Oversight and Performance Assurance Program*

20. Personnel shall demonstrate a familiarity level knowledge of DOE O 151.1C, Comprehensive Emergency Management System, and its implementing guides.

a. Describe the relevant requirements, purpose, interrelationships and importance of the following regulations and directives:
- **10 CFR 830, Nuclear Safety Management**
- **29 CFR 1910.120, Hazardous Waste Operations and Emergency Response**
- **DOE O 151.1C, Comprehensive Emergency Management**
- **DOE G 151.1-1A, Emergency Management Fundamentals and the Operational Emergency Base Program: Emergency Management Guide**
- **DOE G 151.1-2, Technical Planning Basis: Emergency Management Guide**
- **DOE G 151.1-3, Programmatic Elements: Emergency Management Guide**
- **DOE G 151.1-4, Response Elements: Emergency Management Guide**
- **DOE G 151.1-5, Biosafety Facilities: Emergency Management Guide**

10 CFR 830

Purpose

This part governs the conduct of DOE contractors, DOE personnel, and other persons conducting activities, including providing items and services that affect, or may affect, the safety of DOE nuclear facilities.

830.4 General Requirements

- No person may take or cause to be taken any action inconsistent with the requirements of this part.
- A contractor responsible for a nuclear facility must ensure implementation of, and compliance with, the requirements of this part.
- The requirements of this part must be implemented in a manner that provides reasonable assurance of adequate protection of workers, the public, and the environment from adverse consequences, taking into account the work to be performed and the associated hazards.
- If there is no contractor for a DOE nuclear facility, DOE must ensure implementation of, and compliance with, the requirements of this part.

The requirements in this part are DOE Nuclear Safety Requirements and are subject to enforcement by all appropriate means, including the imposition of civil and criminal penalties in accordance with the provisions of 10 CFR 820.

29 CFR 1910.120

This section covers the following operations, unless the employer can demonstrate that the operation does not involve employee exposure or the reasonable possibility for employee exposure to safety or health hazards:

- Clean-up operations required by a governmental body, whether Federal, state, local or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites
- Corrective actions involving clean-up operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended
- Voluntary clean-up operations at sites recognized by Federal, state, local or other governmental bodies as uncontrolled hazardous waste sites
- Operations involving hazardous wastes that are conducted at treatment, storage, and disposal facilities regulated by 40 CFR parts 264 and 265 pursuant to RCRA; or by agencies under agreement with EPA to implement RCRA regulations
- Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

DOE O 151.1C

Objectives

- To establish policy and to assign and describe roles and responsibilities for the DOE Emergency Management System. The Emergency Management System provides the framework for development, coordination, control, and direction of all emergency planning, preparedness, readiness assurance, response, and recovery actions. The Emergency Management System applies to DOE and to the NNSA.
- To establish requirements for comprehensive planning, preparedness, response, and recovery activities of emergency management programs or for organizations requiring DOE/NNSA assistance.
- To describe an approach to effectively integrate planning, preparedness, response, and recovery activities for a comprehensive, all-emergency management concept.
- To integrate public information and emergency planning to provide accurate, candid, and timely information to site workers and the public during all emergencies.

- To promote more efficient use of resources through greater flexibility (i.e., the graded approach) in addressing emergency management needs consistent with the changing missions of the Department and its facilities.
- To ensure that the DOE Emergency Management System is ready to respond promptly, efficiently, and effectively to any emergency involving DOE/NNSA facilities, activities, or operations, or requiring DOE/NNSA assistance.
- To integrate applicable policies and requirements, including those promulgated by other Federal agencies (e.g., stockpiling stable iodine for possible distribution as a radiological protective prophylaxis) and interagency emergency plans into the Department's Emergency Management System. In compliance with the statutory requirements in 42 USC 7274k, DOE hereby finds that this Order is necessary for the fulfillment of current legal requirements and conduct of critical administrative functions.
- To eliminate duplication of emergency management effort within the Department.

General Requirements

- DOE/NNSA sites/facilities, including DOE/NNSA transportation activities, DOE/NNSA offices in the field, and DOE Headquarters offices, must develop and participate in an integrated and comprehensive Emergency Management System to ensure that
  - the Department can respond effectively and efficiently to operational emergencies and energy emergencies and can provide emergency assistance so that appropriate response measures are taken to protect workers, the public, the environment, and the national security;
  - emergencies are recognized, categorized and, as necessary, classified (determine the emergency class) promptly, and parameters associated with the emergency are monitored to detect changed or degraded conditions;
  - emergencies are reported and notifications are made;
  - reentry activities are properly and safely accomplished, and recovery and post-emergency activities commence properly.

DOE G 151.1-1A

The overall mission of DOE emergency management is to be ready to respond promptly, efficiently and effectively to any emergency involving or affecting DOE facilities/sites or activities by applying the necessary resources to mitigate the consequences and protect workers, the public, the environment, and national security. The DOE "comprehensive" emergency management system provides a framework within which to address all hazards, from natural phenomena to terrorist attacks, and all of the components of an effective emergency management program. The standard components of a DOE emergency management program are planning, preparedness, readiness assurance, response, and recovery.

The DOE approach to emergency management is built upon three guiding principles or conceptual "foundation stones" of emergency management. These key concepts are:

- Effective response is the "last line of defense" against adverse consequences. Regardless of how sound the fundamental safety programs and controls may be, events will sometimes happen that have adverse health effects on people and/or the environment. This principle expresses the DOE position that if controls should fail, the facility/site or activity must be prepared to take actions to limit or prevent adverse health and safety impacts to workers and the public. The application of this principle requires some level of emergency response planning even for those events whose severity exceeds the design basis for safety controls (i.e., "beyond-design-basis" events).

- Planning, preparedness, response, and recovery must be specific to and "commensurate with the hazards." The Department is responsible for a large number of different hazards that could threaten the health and safety of workers or the public if released to the environment. These hazards are very different in the nature of their impacts on people, their behavior in the environment and the distance at which adverse impacts would be experienced. While the basic emergency management framework is the same for all DOE facilities/sites or activities, the specific planning and response measures for each hazard are to be tailored to the hazard, such that they are specific (i.e., technically appropriate) to the hazard and commensurate with (in size, scope, or scale) the magnitude of the hazard and its potential impacts.
- "Early recognition" is vital to timely, effective, and commensurate response. In many cases, warning potentially affected workers and the public and directing them to take actions to prevent or limit their exposure is the only way of mitigating the adverse health impacts. Hence, the early recognition of an event is essential if warnings are to be delivered in time to be executed effectively. By developing a full understanding of possible scenarios and the indications that would point to an actual or impending event, emergency management will increase the likelihood of successful warning and intervention to prevent or limit health impacts. This analysis of scenarios and development of recognition indicators provides the basis for tailoring the response to the actual or potential hazard (i.e., commensurate response).

The DOE comprehensive emergency management system is based on a three-tiered management structure consisting of facilities/sites or activities, cognizant field element, and Headquarters, with each tier having specific roles and responsibilities during an emergency. Each organizational tier provides management, direction, and support of emergency response activities. The facility/site or activity manages the tactical response to the emergency by directing the mitigative actions necessary to resolve the problem, protect the workers, the public, and the environment, and return the facility/site to a safe condition. The Cognizant Field Elements oversee the facility/site response and provide local assistance, guidance, and operational direction to the facility/site management; the cognizant field element also coordinates the tactical response to the event with tribal, state, and local governments. DOE Headquarters provides strategic direction to the response, provides assistance and guidance to the cognizant field elements, and evaluates the broad impacts of the emergency on the DOE complex. DOE Headquarters provides strategic direction to the response, provides assistance and guidance to the cognizant field elements, and evaluates the broad impacts of the emergency on the DOE complex. DOE Headquarters also coordinates with other Federal agencies on a national level, provides information to representatives of the executive and legislative branches of the Federal government, and responds to inquiries from the national media.

DOE G 151.1-2

The purpose of this guide is to assist DOE field elements in complying with the DOE O 151.1C requirement that a hazards survey be prepared, maintained, and used for emergency planning purposes. The Order requires that emergency management efforts begin with the identification and qualitative assessment of the facility- or site-specific hazards and the associated emergency conditions that may require response, and that the scope and extent of emergency planning and preparedness at a DOE facility reflect these facility-specific hazards. The first step in the implementation of this "commensurate with hazards" approach to emergency management is a hazards survey.

The hazards survey, which is based on an examination of the features and characteristics of the facility, identifies the generic types of emergency events and conditions, including natural phenomena such as earthquakes and tornadoes, wildland fires, and other serious events involving or affecting health and safety, the environment, and safeguards and security at the facility and the potential impacts of such emergencies to be addressed by the DOE comprehensive emergency management system. The hazards survey also identifies key components of the Operational Emergency Base Program that provide a foundation of basic emergency management requirements and an integrated framework for response to serious emergency events or conditions. Much of the information to be used in the hazards survey, and included in its documentation, should have already been collected in the course of meeting other DOE, NNSA, and Federal, state, tribal, and local authority requirements. For facilities involved in producing, processing, handling, storing, or transporting hazardous materials that have the potential to pose a serious threat to workers, the public, or the environment, the Hazards Survey provides a hazardous material screening process for determining whether further analysis of the hazardous materials in an emergency planning hazards assessment (EPHA) is required.

This guide is directed at operations and emergency management staff responsible for DOE and NNSA facilities at field offices, service centers, and operating contractor organizations. It is expected that emergency management staff will obtain support from site and facility management and from a variety of scientific and technical disciplines within their respective organizations to conduct and document the analyses described in this guide Appendix A of DOE G 151.1-2 provides a recommended screening approach for radioactive and chemical hazardous materials. Appendix B illustrates the application of the suggested hazards survey method to a hypothetical facility and site

DOE G 151.1-3

The purpose of this guide is to assist DOE field elements in complying with the DOE O 151.1C requirement to provide effective organizational management and administrative control of an emergency management program by establishing and maintaining authorities and resources necessary to plan, develop, implement, and maintain a viable, integrated, and coordinated program. Each manager or administrator of a DOE/NNSA contractor-operated facility/site or activity subject to DOE O 151.1C shall designate an individual to administer the emergency management program. This individual shall develop and maintain the emergency plan, develop the Emergency Readiness Assurance Plan and its annual updates, develop and conduct training and exercise programs, coordinate assessment activities, develop related documentation, develop a system to track and verify correction of findings or lessons learned, and coordinate emergency resources. Responsible administrators of emergency management programs should use the guidance in this guide to define responsibilities and implement functions to ensure and maintain effective emergency planning, preparedness, readiness assurance, and response activities.

This guide is designed primarily for facilities/sites or activities that are required to implement an operational emergency hazardous material program and is directed at operations and emergency management staff at field elements and operating contractor organizations responsible for DOE and NNSA facilities/sites or activities.

DOE G 151.1-4

The purpose of this guide is to assist DOE field elements in complying with the DOE O 151.1C requirement to establish and maintain an emergency response organization (ERO) for each facility/site or activity and to ensure that DOE/NNSA EROs are compliant with the National Incident Management System (NIMS). The ERO is a structured organization with overall responsibility for initial and ongoing emergency response to an Operational Emergency (OE) and for mitigation of the consequences. The ERO establishes effective control of response capabilities at the scene of an event/incident and integrates ERO activities with those of local agencies and organizations that provide onsite response services. An adequate number of experienced and trained personnel, including designated alternates, should be available on demand for timely and effective performance of ERO functions.

This guide is designed primarily for facilities/sites and activities that are required to implement an operational emergency hazardous materials program and is directed at operations and emergency management staff at field elements and operating contractor organizations responsible for DOE and NNSA facilities/sites and activities.

DOE G 151.1-5

DOE O 151.1C, Comprehensive Emergency Management System, describes the DOE and Emergency Management System. The Order sets Departmental policy, assigns roles and responsibilities, and provides the framework for the development, coordination, control, and direction for DOE/NNSA emergency management programs. Requirements for emergency planning, preparedness, readiness assurance, and response activities are established and the approach for effectively integrating these activities under a comprehensive, all-emergency concept is described. Using this approach, a DOE/NNSA facility/site develops and participates in an integrated and comprehensive emergency management program to ensure that DOE can respond effectively and efficiently to OEs to protect workers, the public, and the environment.

Emergency management programs are designed to ensure that all emergencies are promptly recognized and categorized, emergencies are reported and notifications are made, and parameters associated with the emergency are monitored to detect changed or degraded conditions.

Since 1991, DOE/NNSA emergency management programs have focused on radioactive materials and hazardous chemicals. However, priorities in national security emphasizing anti-terrorism have caused a change in national security research priorities at DOE/NNSA facilities/sites to include studies involving hazardous biological agents and/or toxins. The use and storage of these materials in DOE/NNSA facilities has the potential to harm workers and the general public, as do toxic chemicals and radioactive materials, through an unplanned event or condition that releases an agent or toxin to the environment.

Integration of hazardous biological materials into the emergency management program is directed by 10 CFR 851, Worker Safety and Health Program, Appendix A, 7. Biological safety. According to this rule, contractors must establish and implement a biological safety program that establishes an Institutional Biosafety Committee (IBC) or equivalent. The IBC must review the site's security, safeguards, and emergency management plans and procedures to ensure they adequately consider work involving biological etiologic (i.e., disease causing) agents. In addition, the biological safety program confirms that the site safeguards and security plans and emergency management programs address biological etiologic agents, with particular emphasis on biological select agents. Other Federal regulations that govern the use and storage of select agents and toxins require that mandated incident response planning be "integrated with any site-wide emergency response plans."

The purpose of this guide is to assist DOE/NNSA field elements and operating contractors in incorporating hazardous biological agents/toxins into emergency management programs. The intended result is an integrated and comprehensive emergency management program that provides assurances of a timely and effective response to an onsite release of a radioactive, toxic chemical, or hazardous biological material. Note that the guidance presented in this document does not explicitly address acts of terrorism in which biological agents or toxins, not owned or controlled by DOE/NNSA, are brought onto a DOE/NNSA site or facility.

b. State what is meant by an operational emergency.

Operational emergencies are major unplanned or abnormal events or conditions that: involve or affect DOE/NNSA facilities and activities by causing or having the potential to cause serious health and safety or environmental impacts; require resources from outside the immediate/affected area or local event scene to supplement the initial response; and, require time-urgent notifications to initiate response activities at locations beyond the event scene.

c. Describe the purpose of the facility emergency plan and implementing procedures.

Emergency management programs for each DOE/NNSA facility/site are documented in an emergency plan. The plan describes provisions for response to operational emergencies and activities for maintaining the emergency management program. The recommended emergency plan format and content for base program facilities is provided in DOE G 151.1-1A, appendix A. A Departmental facility/site with no additional requirements of a hazardous material program must develop and implement an emergency plan for a base program.

Section A.2 of DOE G 151.1-1A contains a recommended format and content for a base program emergency plan. The base program plan explicitly addresses the minimum requirements specified in DOE O 151.1C. Base programs with substantial response requirements (i.e., those having organizational structures and functions similar to a hazardous material program) may use the more detailed plan structure presented in DOE G 151.1-3, chapter 1, appendix A. The appendices are recommended, but not required. As long as the necessary information is contained in the plan, an equivalent format, such as one based on state emergency plans, may be used to ensure local compatibility.

d. Discuss the requirements for developing the hazards survey and the emergency planning hazards assessment.

Hazards Survey

The hazards survey, which is required by DOE O 151.1C for each facility/site or activity, is used to identify the generic emergency events or conditions that define the scope of the emergency management program. The hazards survey is a qualitative examination of the events or conditions specific to the facility/site or activity that may require an emergency response. The description of the potential impacts of such events or conditions (e.g., natural phenomena, wild land fires, hazardous materials releases, malevolent events, etc.) contained in the hazards survey determines the planning and preparedness requirements that apply. These requirements constitute the base program.

The hazards survey is the formal mechanism used to determine the scope and extent of the facility/site or activity base program. If hazardous materials are not present at the facility/site or activity, or are present in quantities less than quantities that are "easily and safely manipulated by one person" (i.e., threshold screening quantities), then the base program appropriately defines the facility/site or activity emergency management program that meets the requirements of DOE O 151.1C. General guidance for the base program requirements and base program facilities is presented in DOE G 151.1-1A, chapter 3, "Operational Emergency Base Program and Base Program Facilities."

EPHA

A facility/site- or activity-specific EPHA is required by DOE O 151.1C to be conducted for each DOE facility/site or activity where identified hazardous materials are present in quantities exceeding the quantity that can be "easily and safely manipulated by one person" and whose potential release would cause the impacts and require response activities characteristic of an operational emergency. An EPHA is a quantitative analysis that includes the identification and characterization of hazardous materials specific to a facility/site or activity, analyses of potential accidents or events, and evaluation of potential consequences. The results of the EPHA determine whether an operational emergency hazardous material program is required. If the analysis results indicate that no potential accident events and conditions would be classified as an alert or higher (as defined in DOE O 151.1C), then the base program, including 29 CFR 1910.120 requirements, constitutes the appropriate emergency management program for the facility/site or activity. If the analysis results associated with a facility/site indicate the potential for an alert, site area emergency, or general emergency as defined in DOE O 151.1C, a hazardous material program is required; the analysis results will also provide the technical planning basis for the hazardous materials emergency management program. The emergency management program that results from the "seamless" integration and coordination of these sets of requirements ("base" plus hazardous materials) becomes the emergency management program for the facility/site or activity. Not every conceivable situation can be analyzed and, hence, not every response can be preplanned. However, the development of an adequate hazards survey and EPHA, in combination with effective and integrated emergency planning and preparedness, provides the framework for response to any emergency event or condition.

e. Describe the key roles and safety considerations during emergency response:
- **National Incident Management System**
- **Incident Command System**
- **Incident commander**
- **Emergency director**

National Incident Management System (NIMS)

For years, DOE requirements and guidance have discussed the need to have an incident command system at the facility/site level that could seamlessly integrate response assets from the surrounding jurisdictions. The NIMS is designed to achieve the same integration at all levels of government. The Department of Homeland Security promulgated NIMS in March 2004, under the authority of Homeland Security Presidential Directive-5. NIMS is the nationwide template enabling Federal, state, local, and tribal governments and private-sector and nongovernmental organizations to work together effectively and efficiently to prevent, prepare for, respond to, and recover from emergencies.

All Federal departments/agencies were required to develop a NIMS implementation plan. The DOE NIMS implementation plan was published in February 2005, requiring all Departmental elements to complete implementation of NIMS by September 30, 2005, or when their surrounding jurisdictions implemented NIMS. The basic requirement, without the implementation date, is included in DOE O 151.1C, chapter IV, paragraph 3b(1). The Department of Homeland Security (DHS) made preparedness grant funding for state, territorial, tribal and local governments contingent upon NIMS compliance after Federal fiscal year 2006. Most local jurisdictions, as well as all DOE/NNSA facilities/sites, should have achieved NIMS compliance by this time.

Incident Command System

During emergency response, a dedicated facility should be available for use as a command center by the emergency director (ED), the emergency management team (EMT) component of the ERO, and other supporting members of the ERO. The command center is the primary onsite emergency facility designed to allow the EMT to fulfill its emergency response functions and responsibilities, based on an analysis of support the designated response functions and assignments. Facility systems and installed equipment (e.g., heating, ventilation, and air conditioning, sanitation, lighting, radiation monitors, computer systems, communications, and visual displays) should be adequate to support the functions and expected level of staffing. The command center should have the capability to access alternate power supplies in the event of a loss of power. If the primary command center becomes unavailable, then provisions should be in place to use an alternative location considering habitability, accessibility, and security, as well as access to power and communications.

Controlled access procedures should maintain security and accountability within the command center. Sufficient space and equipment should be provided to permit the EMT to perform its functions effectively and efficiently using its operations procedures, especially round-the-clock command, control, and communications. The command center should promote the active support of on-scene responders versus simply providing an incident-tracking capability.

A resource area with current electronic and hard-copy reference materials, such as operating procedures, TSRs, emergency plans and procedures, safety analyses, onsite demographic data, evacuation plans, and environmental monitoring records, should be designated and maintained to allow for ready accessibility and use by the EMT.

If the command center is a dual-use facility, then plans and procedures should be in place and tested regularly to ensure that the facility can be rapidly converted into a command center, staff are knowledgeable in carrying out this transition, and facility resources and equipment are adequately maintained to ensure timely conversion, activation, and availability to support an emergency response.

At a minimum, a command center should have the capability to effectively integrate the following five functional elements:

- Command
- Operations
- Planning
- Logistics
- Finance/administration

This configuration meets the intent of the NIMS and describes the basic functional make-up of a NIMS incident command system.

However, depending upon the actual emergency, these elements and their sub-elements should be tailored to needs dictated by the event, not by an automatic, one-size-fits-all configuration. A command center needs to flexibly support management of the facility/site emergency response while coordinating and meeting its Federal, tribal, state, and local obligations.

Incident Commander

The incident commander maintains operational control of the response at the incident scene and transmits information to the command center.

Emergency Director

One position in the facility/site maintenance and operations contractor ERO, the ED or similar title, should have unilateral authority and responsibility to implement the facility/site emergency plan and employ overall emergency management responsibility during response to an operational emergency. Full authority and responsibility implies that this individual should either initially perform, or oversee, the following minimum functions: detect or assess, categorize and classify (as necessary) the emergency event or conditions; carry out initial notifications; implement protective actions onsite; issue offsite protective action recommendations; and initiate response by appropriate emergency resources (such as fire, medical, security and HAZMAT personnel). The position may be transferred to more senior officials once the ERO is fully staffed.

f. Discuss the requirements for testing emergency plans and for interfacing with state and local officials and the public.

The primary inspection goal is to determine, with reasonable certainty, whether the emergency management program is adequately meeting the appropriate standards established by DOE policy and is capable of providing appropriate protection to site personnel and the public in case of an accident at the site. In order to do this, it is necessary to determine whether the emergency management program is adequately managed, staffed, trained, equipped, and capable of performing all mission-related tasks and duties.

While an emergency management program inspection includes compliance and performance activities, a greater emphasis is placed on the performance aspect, as it is more useful in determining whether the ERO can perform its mission. Many of the DOE emergency management requirements contained in DOE O 151.1C are stated in performance terms: that is, they state a capability, duty, or integrated response that must be performed. Therefore, compliance requires effective performance. Even when dealing with policy requirements for which a compliance approach may seem appropriate (e.g., Does the training program contain the required elements?), the approach for this topic is to go beyond compliance and determine the performance aspects of these requirements (e.g., Does the training program adequately prepare the emergency director to perform his/her mission?).

Therefore, whenever possible, data-collecting activities for the emergency management program should be performance-oriented.

Provisions should exist for interface between other agency response personnel and the facility/site and cognizant field element EROs, with clearly defined positions or points-of-contact. Interfaces that require coordination, liaison exchange, or integration, that will also influence the structure of the ERO during an emergency, may include but are not limited to:

- Tenant and visiting national laboratories (for special projects)
- Potential Department of Defense, Defense Threat Reduction Agency, Department of State, EPA, DHS, and Department of Justice/FBI presence
- Offsite organizations including local law enforcement; fire, medical, American Red Cross, local, state, Tribal, and regional Federal agencies; and joint public information groups
- Radiological emergency response assets, such as the Accident Response Group, Nuclear Emergency Support Team, Federal Radiological Monitoring and Assessment Center, Aerial Measuring System, National Atmospheric Release Advisory Center, Radiation Emergency Assistance Center/Training Site, and Radiological Assistance Program
- Organizations such as the Joint Field Office or the National Oil and Hazardous Substance Pollution Contingency Plan organizations
- Organizations under National Interagency Fire Center for wild land fires

These interfaces should be preplanned and described in the emergency plan where applicable. Additional information concerning the interface with offsite emergency response organizations is provided in DOE G 151.1-4, Chapter 2.

References: 10 CFR 830.4, "General Requirements"
29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response"
DOE G 151.1-1A, *Emergency Management Fundamentals and the Operational Emergency Base Program*
DOE G 151.1-4, *Response Elements*
DOE O 151.1C, *Comprehensive Emergency Management System*
Emergency Management Program Evaluation Inspectors Guide, SP-43

21. Personnel shall demonstrate a familiarity level knowledge of the Unreviewed Safety Question (USQ) process as discussed in 10 CFR 830, Subpart B, Nuclear Safety Management.

a. Describe the purpose of the USQ process.

The purpose of 10 CFR 830.203, "Unreviewed Safety Question (USQ) Process," is

- to allow contractors to make physical and procedural changes and to conduct tests and experiments without prior DOE approval if the proposed change can be accommodated within the existing safety basis;
- to alert DOE of events, conditions, or actions that affect the DOE-approved safety basis of the facility or operation and ensure appropriate DOE line management action.

The USQ process provides contractors with the flexibility needed to conduct day-to-day operations by requiring only those changes and tests with a potential to impact the safety basis (and therefore the margin of safety of the nuclear facility) be approved by DOE.

The USQ process is required for Hazard Category 1, 2, and 3 nuclear facilities and is integrated with the facilities change control processes.

10 CFR 830 defines the USQ process as "the mechanism for keeping the safety basis current by reviewing potential USQs, reporting USQs to DOE, and obtaining approval by DOE prior to taking any actions that involves an USQ."

The USQ process involves several steps:

- First, proposed changes to the facility (including facility procedures) are documented.
- Second, some strictly administrative (e.g., editorial) changes are screened out without going through the full USQ process.
- Third, a USQ "determination" is made. If the conclusion is that an USQ exists, then DOE must approve the change before it is implemented. If the conclusion is that an USQ does not exist, then the change may be made without prior DOE approval.

Note: Some changes (e.g., changes to TSRs) must receive prior approval by DOE (whether they constitute an USQ or not), and therefore, do not need to go through the USQ process.

b. Discuss the reasons for performing a USQ determination.

The USQ determination is a formal-documented evaluation of a proposed plant change against specific conditions identified in 10 CFR 830.203. The reason for performing a USQ determination is to determine whether the proposed change would result in the facility being outside its DOE approved safety basis.

The existence of a USQ does not mean that the proposed facility or operation is unsafe but only that proposed change is not within the current safety basis approved by DOE, and that DOE must approve the change prior to it being implemented.

If a change is proposed or a condition is discovered that could increase the risk of operating a facility beyond that established in the current safety basis, DOE line management, must review and determine the acceptability of that risk through the process of approving a revised safety basis that would be developed and submitted by the contractor.

c. Define and discuss key USQ terms.

Accident Analyses

The accident analysis is the section of DSA that evaluates potential accidents and their consequences.

Safety Evaluation

The term "safety evaluation" is used in different manners related to USQ. It is sometime used to denote the contractor review of the safety of a proposed change. However, a more common term used by contractors processing proposed changes is a "USQ determination" which is the contractors documented review of whether a potential change is a USQ. As discussed previously, DOE utilizes the term safety evaluation report to denote its record of review of contractor DSA and USQ submittals.

Technical Safety Requirements (TSRs)

TSRs are limits, controls, and related actions that establish the specific parameters for safe operation of a facility. The TSRs define the approved "safe operating envelope." If a potential plant change results in a need to change a TSR, then prior DOE approval is needed and therefore, there is no need to make a USQ determination.

USQ Determination

USQ Determination is the application of the USQ process to decide whether the observed or proposed changes are "within" the safety basis. The "USQ evaluation (determination)" is the contractor record of whether a potential change is a USQ.

USQ (or Positive USQ)

USQ is a condition that is not within the safety basis. DOE jargon is to call these Positive USQs to avoid confusion with the USQ as a process.

Documented Safety Analysis (DSA)

Documented safety analysis means a documented analysis of the extent to which a nuclear facility can be operated safely with respect to workers, the public, and the environment, including a description of the conditions, safe boundaries, and hazard controls that provide the basis for ensuring safety. [10 CFR 830]

The DSA contains the evaluation of potential accidents and their consequences and defines hazards controls necessary to protect the worker and public. The most important controls become part of the TSR. The DSA contains the analysis which forms the facility safety basis.

Safety Evaluation Report

Safety evaluation report means the report prepared by DOE to document (1) The sufficiency of the documented safety analysis; control settings and limiting conditions for operation are met; (2) The extent to which a contractor has satisfied the requirements of Subpart B of 10 CFR 830; and (3) The basis for approval by DOE of the safety basis for the facility, including any conditions for approval. [10 CFR 830]

A safety evaluation report is the DOE documented review of the facility DSA. The Safety Evaluation report (SER) provides DOE approval and any conditions of approval for the DSA.

Margin of Safety

For purposes of performing the USQ determination, a margin of safety is defined by the range between two conditions. The first is the most adverse condition estimated or calculated in safety analyses to occur from an operational upset or family of related upsets. The second condition is the worst-case value known to be safe, from an engineering perspective. This value would be expected to be related to the condition at which some accident prevention or mitigation action must be taken in response to the upset or accident, as required by a DOE-approved TSR, not the actual predicted failure point of some component.

d. Describe the situations that require a USQ determination.

A USQ determination is performed for

- temporary or permanent changes in the facility as described in the existing safety analyses;
- temporary or permanent changes in the procedures as described in existing safety analyses;
- test or experiments not described in existing safety analyses;
- Existing plant conditions that indicate that the documented safety analysis may not be bounding or may otherwise be inadequate.

The facility includes the equipment associated with the structure as well as the structure itself.

e. Define the conditions for a USQ.

The condition (i.e., proposed plant change or discrepancy) is a USQ if the condition results in

- the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the facility safety analyses could be increased;
- the possibility for an accident or malfunction of a different type than any evaluated previously in the facility safety analyses could be created; or
- a margin of safety, as defined in the bases of the TSRs, could be reduced;
- the DSA may not be bounding or may be otherwise inadequate.

The DOE implementing guide (DOE G 424.1-1) breaks these four criteria down into the following seven questions (If the answer to any of the questions is yes, then a USQ (positive USQ) exists):

- Could the proposed change increase the probability of an accident previously evaluated in the facility's existing safety analyses?
- Could the proposed change increase the consequences (to workers or the public) of an accident previously evaluated in the facility's existing safety analyses?
- Could the proposed change increase the probability of a malfunction of equipment important to safety previously described in the facility's existing safety analyses?
- Could the proposed change increase the consequences of a malfunction of equipment important to safety described in the facility's existing safety analyses?
- Could the proposed change create the possibility of an accident of a different type than any previously evaluated in the facility's existing safety analyses?
- Could the proposed change create the possibility of a malfunction of equipment important to safety of a different type than any previously evaluated in the facility's existing safety analyses?
- Does the proposed change reduce the margin of safety?

f. Describe contractor responsibilities for performing USQ determinations.

Contractors for operating Hazard category 1, 2 and 3 nuclear facilities are responsible for implementing the USQ process.

For all USQ evaluations (safety evaluations) a contractor shall

- document the basis for the USQ determination;
- maintain documentation required for the authorized operating period of the nuclear facility and ensure the complete transfer of all documentation to any contractor prior to termination of its contract;
- incorporate in the existing DSA any changes that are needed as a result of the USQ evaluation or any action taken; and
- submit to DOE, on a schedule corresponding to the periodic updates of the DSA, a report summarizing all situations for which a safety evaluation was required and indicating all changes considered in a safety evaluation and implemented six months or more before the submittal date of the report.

g. Describe site actions for identified potential inadequacy of previous safety analyses.

10 CFR 830.203 requires the following actions when a potential inadequacy in the safety analysis (PISA) is identified:

- Place the facility in a safe condition.
- Notify DOE of the situation.
- Perform a USQ determination.
- Submit an evaluation of the safety of the situation before removing any operational restrictions.

DOE G 424.1 provides expectations for timeliness of processing PISAs. Specifically, the USQ determination should be prepared promptly and the results submitted promptly. The time frame after initial notification of DOE until submittal of the USQ determination results should be on the order of hours or days, not weeks or months.

Reasons a DSA may potentially be inadequate

The DSA may be inadequate for any number of reasons. In general, it is possible for a potentially inadequate analysis to arise from three entry conditions:

- A discrepant as-found condition
- An operational event or incident or
- New information, including discovery or an error, sometimes from an external source

The main consideration is that the analysis does not match the current physical configuration of the facility, or the analysis is inappropriate or contains errors.

The analysis might not match the facility configuration because of a discrepant as-found condition.

Analytical errors might involve using incorrect input values, using invalid assumptions, using an improper model, or calculational errors.

The USQ process starts when the facility management has information that gives reason to believe that there is the *potential* that the facility DSA might be inadequate.

The USQ process does not apply to the process of upgrading DSAs in response to new requirements or to the use of new or different analytical tools during the upgrade process. However, the USQ process does apply when there is reason to believe that the current safety basis might be in error or otherwise inadequate.

h. Discuss site actions to be taken for a USQ.

If a USQ is involved (i.e., a proposed change is determined to be a USQ) then the impact on the safety basis must be defined and DOE must approve of the change (and changes to the safety basis) prior to the change being implemented. DOE might disapprove the change; in that case, the change can not be implemented.

i. Discuss the qualification and training requirements for personnel performing safety evaluations.

Implementing procedures should establish the personnel training and qualifications needed to perform the USQ process. These include required educational background, years and/or types of work experience, knowledge of the facility, understanding of DOE requirements related to the facility safety basis (including the USQ process), and familiarity with the facility-specific safety basis.

All personnel responsible for preparing, reviewing, or approving USQ documents should receive training on the application of Section 830.203, including any facility-specific procedures. The recommended interval for retraining in DOE 424.1-1 is every 2 years.

The contractor should maintain a list of those personnel who are currently qualified to perform the USQ process.

References: 10 CFR 830.203, “Unreviewed Safety Question Process”
DOE G 424.1-1, *Implementing Guide for Use in Addressing Unreviewed Safety Question Requirements*
DOE O 231.1A, *Environment, Safety, and Health Reporting*

22. Personnel shall demonstrate a familiarity level knowledge of the Documented Safety Analysis (DSA) and Technical Safety Requirements (TSRs)of 10 CFR 830 Subpart B, Safety Basis Requirements, and the DOE standards and guides supporting implementation of 10 CFR 830 Subpart B.

a. Define and compare the terms “hazard” and “risk.”

Hazard

Hazard is defined as a source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to a person or damage to a facility or to the environment (without regard to the likelihood or credibility of accident scenarios or consequence mitigation). [DOE G 420.1-1]

Risk

Risk is defined as the quantitative or qualitative expression of possible loss that considers both the probability that an event will occur and the consequence of that event. [DOE G 420.1-1] Risk is the possibility that a hazard will lead to harm. It is a measure of the likelihood of a hazard to cause harm and the consequences of this harm. Example: Frequent exposures causing moderate consequences can have a comparable risk to infrequent exposures resulting in higher consequences.

Hazard/Risk Analysis

A hazard analysis is the determination of material, system, process, and plant characteristics that can produce undesirable consequences, followed by the assessment of hazardous situations associated with a process or activity. Largely qualitative techniques are used to pinpoint weaknesses in design or operation of the facility that could lead to accidents. The Safety Analysis Report hazard analysis examines the complete spectrum of potential accidents that could expose members of the public, onsite workers, facility workers, and the environment to hazardous materials. [DOE-STD-3009-94]

A risk analysis usually involves a combination of qualitative and quantitative analysis.

Qualitative analyses use engineering judgment supported by industry and DOE experience, consensus standards and guidance, and other estimates of event likelihood and potential consequences to characterize risk.

Quantitative analyses provide a numerical risk evaluation through application of models or analysis processes that use numerical values to important likelihood and consequence factors. For example, radiological and chemical exposures leading to consequences can be more precisely estimated using models accounting for concentrations, exposure periods, weather, material form or many other factors.

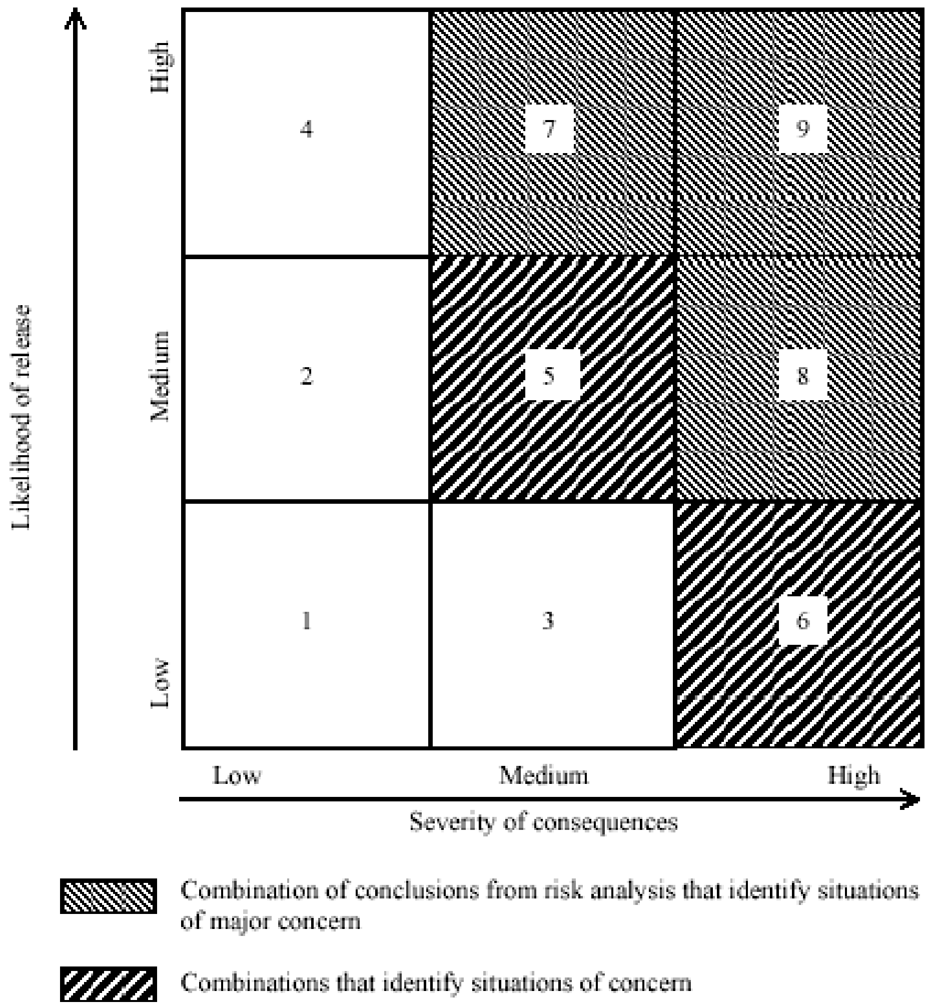
An example of hazard evaluation/risk ranking is shown below.

Qualitative severity classification table

Descriptive word	Description
No	Negligible onsite and offsite impact on people or the environs
Low	Minor onsite and negligible offsite impact on people or the environs
Moderate	Considerable onsite impact on people or the environs; only minor offsite impact
High	Considerable onsite and offsite impacts on people or the environs

Qualitative likelihood classification table

Descriptive word	Estimated annual likelihood of occurrence	Description
Anticipated	$10^{-1}>p>10^{-2}$	Incidents that may occur several times during the lifetime of the facility. (Incidents that commonly occur)
Unlikely	$10^{-2}>p>10^{-4}$	Accidents that are not anticipated to occur during the lifetime of the facility. Natural phenomena of this probability class include Uniform Building Code level earthquake. 100-year flood maximum wind gust, etc.
Extremely Unlikely	$10^{-4}>p>10^{-6}$	Accidents that will probably not occur during the life cycle of the facility. This class include the design basis accidents.
Beyond Extremely Unlikely	$10^{-6}>p$	All other accidents



Likelihood and Consequence Ranking Matrix [From DOE STD 3009]

Risk Factors

The factors that affect risk are

- likelihood or probability of event (that result in an adverse health or environmental impact);
- consequence of event (magnitude of the impact).

Likelihood factors could include (not limiting)

- how often an activity is performed;
- the level of control provided by the structures, systems and components (reliability, design, function, proximity).

Consequences factors could include (not limiting)

- material form, quantity, dispersibility;
- material toxicity or equivalent, pathways;
- exposure mechanisms;
- environmental conditions.

DOE has defined 3 hazard categories in DOE-STD-1027-92:

- Hazard Category 1: The hazard analysis shows the potential for significant offsite consequences.
- Hazard Category 2: The hazard analysis shows the potential for significant onsite consequences.
- Hazard Category 3: The hazard analysis shows the potential for only significant localized consequences.

b. Explain and compare the terms "safety basis," "design basis," and "authorization basis."

Design Basis

Design basis means the set of requirements that bound the design of systems, structures, and components within the facility. These design requirements include consideration of safety, plant availability, efficiency, reliability, and maintainability. Some aspects of the design basis are important to safety, although others are not. [STD-3009]

Authorization Basis

The Authorization Basis is those aspects of the facility design basis and operational requirements relied upon by DOE to authorize operation. These aspects are considered to be important to the safety of the facility operations. The authorization basis includes the safety basis for the facility, which focuses on the protection of personnel, both offsite and onsite. DOE-STD-3009-94 defines safety basis as information relating to the control of hazards at a facility (including design, engineering analyses, and administrative controls) upon which DOE depends for its conclusion that activities at the facility can be conducted safely. The terms authorization basis and safety basis are sometimes used interchangeably. The authorization basis may also include information related to environmental protection. [DOE-STD-3024]

Documents that provide authorization basis information typically include, but are not necessarily limited to, the DSA, SAR, TSRs, EISs, hazard classification documents, DOE-issued Safety Evaluation Reports, and documents containing facility-specific commitments to comply with DOE Orders or policies.

In other words, authorization basis is the results of all analyses, decisions and agreements related to facility design basis and operational requirements that DOE relies upon to authorize a given facility for well defined set of operations. The focus of authorization basis is to assure the safety of the facility operations.

The design basis is a part of the authorization basis.

c. Discuss the relationship of DSAs to TSRs.

TSR

TSRs are the limits, controls, and related actions that establish the specific parameters and requisite actions for the safe operation of a nuclear facility and include, as appropriate for the work and the hazards identified in the documented safety analysis for the facility: Safety limits, operating limits, surveillance requirements, administrative and management controls, use and application provisions, and design features, as well as a bases appendix. [10 CFR 830]

TSRs are those requirements that define the conditions, safe boundaries, and the management or administrative controls necessary to ensure the safe operation of a nuclear facility and to reduce the potential risk to the public and facility workers from uncontrolled releases of radioactive materials or from radiation exposure due to inadvertent criticality.

The TSR defines the requirements necessary to ensure most important hazard controls are implemented. A TSR consists of operating limits, surveillance requirements, administrative controls, use and application instructions, design features and the bases thereof.

DSA

DSAs specifically examine those hazards inherent in processes and related operations that can result in uncontrolled release of hazardous material (i.e., chemical or radiological) or process-unique energy sources (e.g., high pressure autoclave). Standard industrial hazards do not require SAR DSA coverage. Standard industrial hazards such as burns from hot objects, electrocution, falling objects, etc., are of concern only to the degree that they can be a contributor to a significant uncontrolled release of hazardous material (e.g., 115-volt wiring as initiator of a fire) or major energy sources such as explosive energy.

A DSA documents the safety basis and provides detailed information for a determination that the facility can be operated, maintained, shut down, and decommissioned safely.

The TSRs are directly derived from the controls identified in the DSA.

The approved DSA, TSRs, and other supporting hazard analysis or control documents contain the principal safety basis for a DOE decision to authorize facility operation. Once facility operation is authorized, the final DSA, TSRs, and hazard controls will be the principal safety bases for sustaining authorization and safety oversight.

d. Describe the contractor responsibilities for TSRs and DSAs.

A contractor responsible for the operation of a DOE nuclear facility shall prepare DSAs and TSRs for the facility, submit the DSAs and TSRs to the Program Secretarial Officer (PSO) for approval, and operate the facility in accordance with the TSRs as approved by the PSO, including any modification by the PSO.

Development of a DSA or preliminary documented safety analysis is the process whereby facility hazards are identified, controls to prevent and mitigate potential accidents involving those hazards are proposed, and commitments are made for design, construction, operation, and disposition so as to assure adequate safety at DOE nuclear facilities. DOE, in its review and approval role, may require modification or addition to these commitments by the responsible contractor.

Throughout the life of the facility, from design and construction to mission-oriented operations, through deactivation, long-term surveillance and maintenance, to decontamination and decommissioning, there must be a safety basis in place that is appropriate to the activities (operations) occurring during each of those phases.

The TSR and its appendices constitute an agreement or contract between DOE and the facility operating management regarding the safe operation of the facility. As such, they cannot be changed without PSO approval.

TSRs should be written in a clear and concise manner, in language that is directed at and clearly understandable by those in the facility operating organization. The TSR should not contain excessive details that are more appropriate to the DSA.

e. Define the following terms and discuss the purpose of each:

- **Safety limit**
- **Limiting control settings**
- **Limiting conditions for operation**
- **Surveillance requirements.**

Safety Limit (SL)

SLs are limits on important process variables needed for the facility function that, if exceeded, could directly cause the failure of one or more of the passive barriers that prevent the uncontrolled release of radioactive materials, with the potential of consequences to the public above specified evaluation guidelines. [DOE G 423.1-1]

If any SL is exceeded at any reactor or nonreactor nuclear facility, action shall begin immediately to place the facility in the most stable, safe condition attainable, including total shutdown of either reactor or nonreactor nuclear facilities. The appropriate time frame for the completion of the action for each nuclear facility has to be developed and justified by the contractor, as appropriate, in the TSR document which requires PSO approval. The SLs shall describe the action to be taken when an SL is exceeded. If an SL is exceeded, the contractor shall notify DOE, review the matter, and record the results of the review. The review shall include the cause of the condition and the basis for any corrective actions taken to preclude reoccurrence. The safe, stable condition entered as corrective action shall be maintained until the cognizant program manager authorizes further operations.

Example:

2.1 SAFETY LIMITS

2.1.1 REACTOR COOLANT SYSTEM (RCS) PRESSURE SAFETY LIMIT

SL: The RCS shall be maintained < 1000 psia

APPLICABILITY: Operation Mode

ACTIONS:
1. Go to SHUTDOWN mode IMMEDIATELY,
2. Notify the DOE CSO within one hour of reaching SHUTDOWN mode, and
3. Prohibit facility operation until authorized by DOE.

Limiting Control Settings

Limiting control settings (LCS) define the settings on safety systems that control process variables to prevent exceeding an SL. [DOE G 423.1-1]

LCSs for reactors should include reactor trip system instrumentation set points. The reactor trip set-point limits are the nominal values at which the reactor trips are set and should be selected to provide sufficient allowances between the trip set point and the SL. This allowance will ensure the core and the reactor coolant system are prevented from exceeding SLs during normal operation and anticipated operational occurrences.

LCSs of instruments that monitor process variables at nonreactor nuclear facilities are the settings that either initiate protective devices themselves or sound an alarm to alert facility personnel to take action to protect barriers that prevent the uncontrolled release of radioactive materials. An LCS is only specified for a variable that also protects an SL. LCSs should be chosen so that there is adequate time after exceeding the setting to correct the abnormal situation, automatically or manually, before an SL is exceeded.

Example:

3/4.2 LIMITING CONTROL SETTINGS

3.2 HEATING GLOVEBOX, HEATING TEMPERATURE LIMITING CONTROL SETTING

LCS: The temperature setting of the Temperature Control Heating Shutoff shall be no greater than the Safety Limit (SL 2.1) minus 36° C.

MODE APPLICABILITY: Operational and Maintenance when unstable materials and Plutonium are present in the heating glovebox

ACTIONS:

CONDITIONS	REQUIRED ACTION	COMPLETION TIME
A. The temperature setting in the temperature control heating shutoff exceeds the Safety Limit (SL 2.1) minus 36ºC.	A.1 Shutoff power to the heaters in the affected heating glovebox.	**IMMEDIATELY**
	AND	
	A.2 Evacuate the facility of all personnel, except for those directly involved with corrective actions.	**IMMEDIATELY**
	AND	
	A.3 Repair and functionally test the affected heating glovebox and equipment.	Before returning power to the heaters in the affected heating glovebox

Limiting Conditions for Operation (LCO)

LCOs define the limits that represent the lowest functional capability or performance level of safety SSCs required to perform an activity safely. LCOs should include the initial conditions for those design basis accidents or transient analyses that involve the assumed failure of, or present a challenge to, the integrity of the primary radioactive material barrier.

Identification of these variables should come from a search of each transient and accident analysis documented in the DSA. The LCO should be established at a level that will ensure the process variable is not less conservative during actual operation than was assumed in the safety analyses. LCOs should also include those SSCs that are part of the primary success path of a safety sequence analysis, and those support and actuation systems necessary for them to function successfully. Support equipment for these SSCs would normally be considered to be part of the LCO if relied upon to support the SSCs function.

This subsection of the TSRs shall contain the limits on functional capability or performance level. Examples of LCOs are “ventilation system must be operable” and “Fire Protection system must be operable.”

When an LCO is not met, the contractor shall take remedial actions defined by the TSRs until the condition can be met. The LCO shall describe the action to be taken in case of exceedance of the LCO.

Example:

3/4.3 LIMITING CONDITIONS FOR OPERATION

3.2 HEATING GLOVEBOX TEMPERATURE SHUTOFF CONTROL SYSTEM

LCO: Each Heating Glovebox shall have two OPERABLE Heating Glovebox Temperature Control Shutoff systems and one OPERABLE temperature recorder.

MODE APPLICABILITY: Operation and Maintenance when unstable materials are present in the heating glovebox and plutonium is present

ACTIONS:

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One heating glovebox temperature control shutoff is not OPERABLE	A.1 Shutoff power to the heaters in the affected heating glovebox.	**IMMEDIATELY**
	AND	
OR the temperature recorder is not OPERABLE.	A.2 Repair the affected heating glove box and equipment.	Before returning power to the heaters in the affected heating glovebox

Surveillance Requirements (SRs)

SRs are used to ensure operability or availability of the safety SSCs. SRs are most often used with LCOs to periodically validate the operability of active systems or components that are subject to a limiting condition.

SRs consist of short descriptions of the type of surveillance required and its frequency of performance.

SURVEILLANCE REQUIREMENTS

SURVEILLANCE REQUIREMENT		FREQUENCY
SR 4.3.1.1	Perform a TRIP ACTUATING DEVICE OPERATIONAL TEST on each fire detector instrument.	Semiannually
SR 4.3.1.2	Demonstrate that the NFPA Standard 72D supervised circuits supervision associated with the detector alarms of each fire detection instrument are OPERABLE.	Semiannually
SR 4.3.1.3	Demonstrate that the unsupervised circuits associated with detector alarms between the instrument and the control room are OPERABLE.	Monthly

f. Discuss the possible source documents that may be used in developing TSRs.

The DSA required by 10 CFR 830.204 furnishes the technical basis for TSRs. For some facilities, other documentation such as the SER may provide additional safety controls or operating restrictions that should be reflected in the TSRs. The TSR derivation section in the DSA is intended to provide a link between the safety analysis and the list of variables, systems, components, equipment, and administrative procedures that must be controlled or limited in some way to ensure safety.

g. Discuss the conditions that constitute a violation of TSRs.

Violations of a TSR occur as a result of the following four circumstances:

- Exceeding an SL
- Failure to complete an ACTION statement within the required time limit following exceeding an LCO or failing to comply with an LCO
- Failure to perform a surveillance within the required time limit
- Failure to comply with an Administrative Control (AC) statement

Failure to comply with an AC statement is a TSR violation when either the AC is directly violated, as would be the case with not meeting minimum staffing requirements for example, or the intent of a referenced program is not fulfilled. To qualify as a TSR violation, the failure to meet the intent of the referenced program would need to be significant enough to render the DSA summary invalid.

TSR violations involving SLs require the facility to begin immediately to go to the most stable, safe condition attainable, including total shutdown.

Reporting of all TSR violations should be made in accordance with the provisions of DOE O 232.1A, *Occurrence Reporting and Processing of Operations Information*.

The reporting of violations on ACs can involve judgment since the details of programs like, a program for criticality control do not appear directly as a TSR, and some program requirements are more important than others. Violations of controls identified in the accident or criticality scenarios in the DSA should be reported as if the were TSR violations.

h. State the general requirements for a DSA and for a preliminary documented safety analysis.

Documented Safety Analysis

The contractor responsible for a hazard category 1, 2, or 3 DOE nuclear facility must obtain approval from DOE for the methodology used to prepare the documented safety analysis for the facility unless the contractor uses a methodology set forth in table 2 of appendix A to 10 CFR 830.

The documented safety analysis for a hazard category 1, 2, or 3 DOE nuclear facility must, as appropriate for the complexities and hazards associated with the facility

- describe the facility (including the design of safety structures, systems and components) and the work to be performed;
- provide a systematic identification of both natural and man-made hazards associated with the facility;
- evaluate normal, abnormal, and accident conditions, including consideration of natural and man-made external events, identification of energy sources or processes that might contribute to the generation or uncontrolled release of radioactive and other hazardous materials, and consideration of the need for analysis of accidents which may be beyond the design basis of the facility;
- derive the hazard controls necessary to ensure adequate protection of workers, the public, and the environment, demonstrate the adequacy of these controls to eliminate, limit, or mitigate identified hazards, and define the process for maintaining the hazard controls current at all times and controlling their use;
- define the characteristics of the safety management programs necessary to ensure the safe operation of the facility, including (where applicable) quality assurance, procedures, maintenance, personnel training, conduct of operations, emergency preparedness, fire protection, waste management, and radiation protection; and
- with respect to a nonreactor nuclear facility with fissionable material in a form and amount sufficient to pose a potential for criticality, define a criticality safety program that
  - ensures that operations with fissionable material remain subcritical under all normal and credible abnormal conditions;
  - identifies applicable nuclear criticality safety standards, and
  - describes how the program meets applicable nuclear criticality safety standards.

Preliminary Documented Safety Analysis

If construction begins after December 11, 2000, the contractor responsible for a hazard category 1, 2, or 3 new DOE nuclear facility or a major modification to a hazard category 1, 2, or 3 DOE nuclear facility must

- prepare a preliminary documented safety analysis for the facility,
- obtain DOE approval of
  - the nuclear safety design criteria to be used in preparing the preliminary documented safety analysis unless the contractor uses the design criteria in DOE Order 420.1, *Facility Safety;*
  - the preliminary documented safety analysis before the contractor can procure materials or components or begin construction; provided that DOE may authorize the contractor to perform limited procurement and construction activities without

approval of a preliminary documented safety analysis if DOE determines that the activities are not detrimental to public health and safety and are in the best interests of DOE.

References: DOE G 421.1-2, *Implementation Guide for Use in Developing Documented Safety Analyses to Meet Subpart B of 10 CFR 830*
DOE G 423.1-1, *Implementation Guide for Use in Developing Technical Safety Requirements*
DOE M 231.1-2, *Occurrence Reporting and Processing of Operations Information*
DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*
DOE-STD-1186-2004, *Specific* Administrative Controls
DOE-STD-3009-94, Ch 2, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analysis Reports"
DOE-STD-3024-98, *Content of System Design Descriptions*

23. Personnel shall demonstrate a familiarity level knowledge of DOE O 420.1B, Facility Safety.

a. Discuss the purpose and applicability of DOE O 420.1B, Facility Safety.

The purpose of this Order is to establish safety requirements for DOE/NNSA for
- nuclear safety design
- criticality safety
- fire protection
- natural phenomena hazards mitigation
- a system engineer program

This Order applies to all DOE-owned or DOE-leased facilities. However, while some sections (e.g., sections 4.2 and 4.4) apply to all facilities, others only apply to certain types of facilities. For example:
- All DOE nonreactor nuclear facilities that are classified as hazard category 1, 2, or 3; and explosives facilities must also meet sections 4.1 and 4.3 of the Order.
- All DOE hazard category 1, 2, and 3 nuclear facilities must also meet section 4.5 of the Order.

These requirements apply to the activities of design and construction of new DOE nuclear facilities and of modifications to existing DOE hazard category 1, 2, and 3 non-reactor nuclear facilities when the proposed modifications significantly degrade the approved Facility Safety for the facility.

Modifications to facility design and construction during the design and construction phase shall conform to the requirements for new facilities. Activities associated with facility deactivation at end of life are exempt if justified by safety analysis.

The contractor shall apply the mandatory standards for the design and construction of DOE explosives facilities or modifications thereof. Explosives facilities are those facilities or locations used for storage of or operations with explosives or ammunition. When these facilities are also nuclear facilities, the requirements for nuclear safety design also apply.

b. Discuss the requirements imposed by DOE O 420.1B on the contractors that operate DOE nuclear facilities.

Regardless of the performer of the work, the contractor is responsible for complying with requirements of the Contractor Requirements Document (CRD). The contractor is responsible for flowing down the requirements to subcontractors at any tier to the extent necessary to ensure the contractor’s compliance with the requirements and the safe performance of work. In doing so, the contractor must not flow down requirements to subcontractors unnecessarily or imprudently.

The CRD establishes facility safety requirements for DOE and NNSA contractors responsible for design, construction, operation, management, decontamination or decommissioning of DOE sites or facilities. Contractors must comply with the CRD requirements to the extent set forth in their contracts. Contractors should refer to corresponding requirements in DOE O 420.1B, *Facility Safety*, dated 12-22-05, and all referenced rules, guidance, and standards when implementing the requirements of this CRD.

Chapters of the CRD may have general and specific requirements. In complying with the CRD, contractors must determine acceptability of design and operations based on a comparison with available safety basis information.

In complying with the CRD, contractors must ensure that any work done is consistent with any other safety, design, or other analysis or requirements applicable to the affected facility. In particular, work must be performed in accordance with the integrated safety management requirements of Title 48 Code of Federal Regulations (CFR) 970.5223-1, “Integration of Environment, Safety, and Health into Work Planning and Execution,” and the quality assurance requirements of either Subpart A of 10 CFR Part 830, “Nuclear Safety Management,” or DOE O 414.1C, *Quality Assurance,* dated 6-17-05, or successor document, as applicable. All new construction, as a minimum, must comply with national consensus industry standards and the model building codes applicable for the state or region supplemented in a graded manner with additional safety requirements for the associated hazards in the facility that are not addressed by the codes.

The depth of detail required and the magnitude of resources expended is commensurate with the relative importance to safety, environmental compliance, safeguards and security, programmatic importance, magnitude of hazard, financial impact, and/or other facility-specific requirements (DOE O 430.1B, *Real Property Asset Management*, dated 9-24-03).

DOE implementation guidance and technical standards referenced in this CRD are not mandatory; however they must be considered in conjunction with the specific requirements. Such guidance, along with both DOE and industry standards referenced therein, represent acceptable methods to satisfy the provisions of this CRD. Alternate methods that satisfy the requirements of this CRD are also acceptable. Any implementation method selected must be justified to ensure that an adequate level of safety commensurate with the identified hazards is achieved.

c. Discuss, in general terms, the focus and content of the following sections of DOE O 420.1B:

- **Nuclear safety**
- **Fire protection**
- **Nuclear criticality safety**
- **Natural phenomena hazards mitigation**
- **Explosives safety**
- **Safety systems engineer and configuration management**

Nuclear Safety

The objectives of nuclear safety are

- to ensure that new DOE hazard category 1, 2, and 3 nuclear facilities are designed and constructed in a manner that ensures adequate protection to the public, workers, and the environment from nuclear hazards;
- to ensure that major modifications to hazard category 1, 2, and 3 nuclear facilities comply with the design and construction requirements for new hazard category 1, 2, and 3 nuclear facilities;
- to ensure that new DOE nuclear reactors comply with the requirements of this Order and the design requirements of DOE O 5480.30, Nuclear Reactor Safety Design Criteria.

Fire Protection

The objectives of fire protection are to establish requirements for a comprehensive fire and related hazards protection program for facilities sufficient to minimize the potential for

- the occurrence of a fire or related event;
- a fire that causes an unacceptable onsite or onsite release of hazardous or radiological material that will threaten the health and safety of employees, the public, or the environment;
- vital DOE programs suffering unacceptable interruptions as a result of fire and related hazards;
- property losses from a fire and related events exceeding defined limits established by DOE;
- critical process controls and safety class systems being damaged as a result of a fire and related events.

Fire protection requirements

DOE facilities, sites, and activities shall be characterized by a level of fire protection that is sufficient to fulfill the requirements of the best protected class of industrial risks and shall be provided protection to achieve defense in depth. This includes meeting the applicable building code and National Fire Protection Association codes and standards, or exceeding them, unless explicit written relief has been granted by DOE.

A fire protection program shall

- establish requirements for a comprehensive fire and related hazards protection program for facilities sufficient to minimize the likelihood and magnitude of fires and for protecting against loss;
- implement Emergency response and management plans;

- provide and protect engineered fire protections systems (sprinklers, alarms, life safety code egress, adequate water, control contaminated fire water runoff);
- develop and use results of Fire Hazards Analysis to support Safety Bases and facility design and operations (e.g., noncombustible construction, flammable loading limits);
- design fire protection systems so that their inadvertent operation, inactivation, or failure of structural stability will not result in the loss of vital safety functions.

Nuclear Criticality Safety

The objective of Section 4.3, Nuclear Criticality Safety, is to establish nuclear criticality safety program requirements to ensure that

- criticality safety is comprehensively addressed and receives an objective review, with all identified risks reduced to acceptably low levels and management authorization of the operation documented;
- the public, workers, property, both government and private, the environment, and essential operations are protected from the effects of a criticality accident.

Requirements

Operations with fissionable materials which pose a criticality accident hazard shall be evaluated and documented to demonstrate that the operation will be sub-critical under both normal and credible abnormal conditions. Fissionable material operations shall be conducted in such a manner that consequences to personnel and property that result from a criticality accident will be mitigated. No single credible event or failure shall result in a criticality accident having unmitigated consequences.

The nuclear criticality safety program shall be evaluated and documented and shall include

- nuclear criticality safety evaluations for normal and credible abnormal conditions that document the parameters, limits, and controls required to ensure that the analyzed conditions are sub-critical;
- implementation of limits and controls identified by the nuclear criticality safety evaluations;
- reviews of operations to ascertain that limits and controls are being followed and that process conditions have not been altered such that the applicability of the nuclear criticality safety evaluation has been compromised;
- assessment of the need for criticality accident detection devices and alarm systems, and installation of such equipment where total risk to personnel will be reduced.

An important concept in criticality safety is the "double contingency" which specifies that process designs shall incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible.

Protection shall be provided by either (i) the control of two independent process parameters (which is the preferred approach, when practical, to prevent common-mode failure), or (ii) a system of multiple controls on a single process parameter. The number of controls required upon a single controlled process parameter shall be based upon control reliability and any features that mitigate the consequences of control failure. In all cases, no single credible event or failure shall result in the potential for a criticality accident, except as referenced in the paragraph that follows.

Natural Phenomena Hazards Mitigation

The objective of Natural Phenomena Hazards Mitigation is to ensure that all DOE facilities are designed, constructed, and operated so that the general public, workers, and the environment are protected from the impact of natural phenomena hazards (NPHs) such as seismic, wind, flood, and lightning.

The Order defines the design criteria that ensure SSCs (safety and critical process equipment inside structures) shall be designed, constructed, and operated to withstand the effects of natural phenomena as necessary to ensure the confinement of hazardous material, the operation of essential facilities, the protection of government property, and the protection of life safety for occupants of DOE buildings.

Design criteria are based on frequency and magnitude of credible NPH events and applied using a graded approach depending on the facility hazards and potential for loss. More robust design criteria is required for more energetic NPH events.

Explosives Safety

The objective of Explosives Safety is to establish mandatory design and construction standards for safety in new DOE explosives facilities and for major modifications to such facilities. Explosives facilities include facilities and locations used for storage or operations with explosives or ammunition.

Safety Systems Engineer

General Requirements

Hazard category 1, 2, and 3 nuclear facilities must have a system engineer program, as well as a qualified cognizant system engineer (CSE) assigned to each system within the scope of the program.

System engineer programs must be incorporated into the ISMS, must flow down from site and facility implementing procedures, and must define CSE functions, responsibilities, and authorities.

A graded approach must be used in applying the requirements of the system engineer program.

Configuration Management

An objective of the system engineer program is to ensure operational readiness of the systems within its scope. To achieve this, the principles of configuration management must be applied to these systems. Consequently, the following requirements are considered integral parts of the systems engineer program:

- Configuration management must be used to develop and maintain consistency among system requirements and performance criteria, documentation, and physical configuration for the SSCs within the scope of the process.

    - Configuration management must integrate the elements of system requirements and performance criteria, system assessments, change control, work control, and documentation control.
    - System design basis documentation and supporting documents must be compiled and kept current using formal change control and work control processes or, when design basis information is not available, documentation must include
        - system requirements and performance criteria essential to performance of the system's safety functions,
        - the basis for system requirements, and
        - a description of how the current system configuration satisfies the requirements and performance criteria.
    - Key design documents must be identified and consolidated to support facility safety basis development and documentation.
    - System assessments must include periodic review of system operability, reliability, and material condition. Reviews must assess the system for
        - ability to perform design and safety functions,
        - physical configuration as compared to system documentation, and
        - system and component performance in comparison to established performance criteria.
- System maintenance and repair must be controlled through a formal change control process to ensure that changes are not inadvertently introduced and that required system performance is not compromised.
- Systems must be tested after modification to ensure continued capability to fulfill system requirements.

References: DOE-O 420.1B, *Facility Safety*
DOE-STD-3024-98, *Content of System Design Descriptions*

24. Personnel shall demonstrate a familiarity level knowledge of DOE P 226.1, Department of Energy Oversight Policy, and its implementing Order DOE O 226.1, Implementation of Department of Energy Oversight Policy.

a. Discuss the purpose and scope of DOE P 226.1, Department of Energy Oversight Policy.

The purpose of this policy is to establish a Department-wide oversight process to protect the public, workers, environment, and national security assets and to perform its business operations effectively through continuous improvement.

The scope of this policy includes assurance systems implemented by DOE contractors and DOE organizations that manage or operate on site; oversight programs implemented by DOE line management (both Headquarters and field elements); and DOE independent oversight organizations. This policy covers such operational aspects as environment, safety, and health; safeguards and security; cyber security; emergency management; and business operations.

b. Discuss DOE's oversight model.

DOE Oversight encompasses activities performed by DOE organizations to determine the effectiveness of Federal and contractor programs and management systems, including assurance and oversight systems. Oversight programs include operational awareness activities, onsite reviews, assessments, self-assessments, performance evaluations, and other activities that involve evaluation of contractor organizations and Federal organizations that operate Government-owned sites.

It is DOE policy to implement assurance systems and oversight programs that include the following four essential elements:

- A comprehensive and rigorous assurance system at all sites implemented by the contractor (for Government-owned/contractor-operated sites) and Federal organizations (for Government-owned/Government-operated sites) that manage or operate on a DOE site
- DOE field element line management oversight processes, such as inspections, reviews, surveillances, surveys, operational awareness, and walkthroughs, that evaluate programs and management systems and the validity of the site assurance system
- DOE Headquarters line management oversight processes that are focused on the DOE field elements and also look at contractor activities to evaluate the implementation and effectiveness of field element line management oversight
- Independent oversight processes that are performed by DOE organizations that do not have line management responsibility for the management of the activity and thus provide an independent perspective for senior management on the effectiveness of programs and activities at all organizational levels (Headquarters, field, and contractor)

c. Describe the roles and responsibilities of the Central Technical Authorities, the Chief of Defense Nuclear Safety and the Chief of Nuclear Safety, program offices and field offices, facility representatives and safety system oversight personnel.

Central Technical Authorities

Central technical authority maintains operational awareness, especially with respect to complex, high-hazard nuclear operations, for ensuring that the Department's safety policies and requirements are adequate and properly implemented.

Chief of Defense Nuclear Safety

The Chief of Defense Nuclear Safety

- supports the central technical authority in establishing and implementing nuclear safety policies, regulations, and directives in a consistent and effective manner;
- encourages, challenges, and assists site offices and HQ elements in promoting nuclear safety consistent with the principles of integrated safety management;
- promotes the elimination of hazards where plausible and the development of effective controls to reduce risks;
- ensures technical inquisitiveness by promoting technical debate and serving as the focal point for addressing complex-wide safety issues affecting nuclear facilities.

Chief of Nuclear Safety

The Chief of Nuclear Safety provides operational awareness and technical nuclear safety advice to senior DOE line managers.

Heads of Field Organizations/Heads of Contracting Activities

The Heads of Field Organizations/Heads of Contracting Activities

- Incorporate the CRD (Attachment 2) into all DOE contracts pursuant to 48 CFR 970.5204-2, "Laws, regulations, and DOE directives," by notifying contracting officers of affected contracts;
- Maintain appropriate qualification standards for personnel with oversight responsibilities and clear, unambiguous lines of authority and responsibility for oversight;
- Establish and implement line management oversight programs and processes consistent with the requirements of this Order, to include Attachment 3, or comparably effective criteria established by the responsible program office;
- Provide unfettered access to information and facilities to conduct an effective oversight program, consistent with applicable laws and requirements;
- Establish and implement effective DOE line management oversight processes consistent with the provisions of Attachments 2 and 3 for Government-owned and Government-operated facilities and DOE sites under the field organizations' cognizance;
- Review, concur, and forward contractor assurance system program descriptions for Headquarters line management approval. If approval authority is delegated by the Headquarters organization, approve contractor assurance system program descriptions. If existing processes (e.g., quality assurance program or integrated safety management description documents) provide adequate descriptions of the contractor assurance programs, or if such processes can be modified to provide adequate descriptions, submittals under these processes can be used to meet this requirement;
- Revise field element policies and implementing procedures and require that site-specific policies and implementing procedures conform to DOE P 226.1 during the established review and revision cycle but no later than one year after the effective date of this Order; and ensure they are consistent with this Order, to include Attachments 2 and 3, or comparably effective criteria established by the responsible program office;
- Use the results of DOE line and independent oversight and contractor assurance systems to make informed decisions about corrective actions.

Facility Representatives

Facility Representatives are responsible for the following:

- Evaluating facility implementation of the notification and reporting process to ensure it is compatible with and meets the requirements of DOE M 232.1-2
- Maintaining day-to-day operational oversight of contractor activities, as described in DOE-STD-1063-2003, *Facility Representatives*
- Ensuring that occurrences that may have generic or programmatic implications are identified and elevated to the Head of the Field Element for appropriate action

- Ensuring that facility personnel act to minimize and prevent recurrence of significant events
- Reviewing and assessing reportable occurrence information from facilities under their cognizance to determine the acceptability of the Facility Manager's evaluation of the significance, causes, generic implications, and corrective action implementation and closeout, and to ensure that facility personnel involved in these operations perform the related functions

Safety System Oversight Personnel

Safety system oversight personnel are responsible for the following:

- Maintaining communication and oversight of systems and monitor performance of the contractor's CSE program
- Attending selected contractor meetings with facility representatives and contractor personnel responsible for system performance (e.g., CSEs design authorities, and program managers), review system health/status reports, review test results, interface with external organizations that can provide insights on performance, and perform other oversight activities on a routine basis
- Performing assessments, periodic evaluation of equipment configuration and material condition. The effect of aging on system equipment and components, the adequacy of application of work control and change control processes, and appropriateness of system maintenance and surveillance should be considered with respect to reliable performance of safety functions
- In conjunction with facility representatives, performing evaluations of contractor troubleshooting, investigations, root cause evaluations, and selection and implementation of corrective actions. May be requested to respond to off normal and/or off normal hours events and investigations and be able to provide relevant insights and serve as the DOE recognized expert on issues related to assigned areas
- Providing support to other Federal employees as appropriate. (This may include program and project managers responsible for supervision of facility safety systems installed in new and modified facilities. It may also include those managing the implementation of ISM in the operation, maintenance, and configuration management of facility safety systems.)
- Assessing contractor compliance with relevant DOE regulations, industry standards, contract requirements, safety basis requirements, and other system requirements
- Confirming configuration documentation, procedures, and other sources of controlling information are current and accurate
- Reporting potential or emergent hazards immediately to DOE line management and facility representatives, and stop tasks, if required, to prevent imminent impact to the health and safety of workers and the public, to protect the environment, or to protect the facility and equipment and immediately notify the on-duty or on-call facility representative
- May serve as a qualifying official in the development or revision of functional area qualification standard (FAQS), mentor assigned backups, and qualify other candidates to the same FAQS attained to achieve safety system oversight qualification
- Maintaining cognizance of the appropriate funding and resources to maintain and improve safety systems

- May perform additional duties and responsibilities, as assigned by their respective field element managers, if needed to meet specific requirements of their sites/facilities, systems/program activities, or other involved organizations

d. Describe the roles and responsibilities the DOE's Office of Independent Oversight.

The Office of Independent Oversight provides DOE line management, Congress, and other stakeholders with an independent evaluation of the effectiveness of DOE policy and line management performance in safeguards and security; cyber security; emergency management; environment, safety and health; and other critical areas as directed by the Secretary.

e. Describe "assurance systems" as found in DOE P 226.1.

Assurance systems encompass all aspects of the activities designed to identify deficiencies and opportunities for improvement, report deficiencies to the responsible managers, and complete corrective actions effectively.

f. Describe the attributes of effective oversight.

An effective oversight process incorporates the following attributes into the four essential elements of oversight as appropriate.

Program Plan

Documented program plans need to identify the program areas to be reviewed, the periodicity of reviews, the reviews necessary to maintain the baseline oversight program, the qualifications of review personnel, and the source of review criteria. Documented program plans need to describe the various oversight methods used, how they are used, and how the results of the various methods are integrated and considered as a whole to give an accurate oversight picture.

Continuous Improvement

Assurance systems and oversight processes will identify ways to make programs more effective and efficient through improved performance and report such opportunities to line managers for their consideration. Line managers at all levels—from the Secretary of Energy to the DOE program office to the field element to the contractor—are responsible for using the results of DOE line and independent oversight processes and assurance systems. These results are to be used to make informed decisions about corrective actions that will improve the effectiveness and efficiency of their programs and operations and about the acceptability of residual risks. The use of external, nationally recognized experts should be considered to carry out independent risk and vulnerability studies and to validate that contractor management systems meet applicable standards. DOE sites and DOE line management must have effective processes for communicating issues up the management chain to senior management using a graded approach that considers hazards and risks. The processes must provide sufficient technical basis to allow managers to make informed decisions. Processes for resolving disputes about oversight findings and other significant issues shall also be implemented and include provisions for independent technical reviews of significant issues.

Requirements and Performance Objectives

DOE oversight programs and assurance systems will evaluate performance against requirements and performance objectives, which may include laws, regulations, national standards, DOE directives, DOE-approved plans and program documents (e.g., security plans, authorization basis documents, and quality assurance plans), site-specific procedures/manuals, criteria review and approach documents, other contractually mandated requirements, and contractual performance objectives. Requirements and performance objectives are established and interpreted through approved processes so that they are relevant to the site and mission.

Personnel Competence

Personnel responsible for managing and performing assurance and oversight functions will possess experience, knowledge, skills, and abilities commensurate with their responsibilities. Line managers are responsible for ensuring that their personnel with oversight responsibilities meet applicable qualifications standards. Continuing training and professional development activities are encouraged to supplement individual experience and provide a means to maintain awareness of changes and advances in the various fields of expertise.

Baseline Oversight Program and Priorities

Headquarters, field and contractor line management are responsible and accountable for establishing and implementing a baseline oversight program that provides for an adequate assessment of programs, management systems, and assurance systems. Clear and unambiguous lines of authority and responsibility for performing line management oversight functions will be established and maintained. Line management will provide its oversight processes with sufficient resources and access to conduct an effective oversight program. Site assurance systems and DOE oversight processes will be tailored to be effective and efficient and will take into account hazards and risks (including risks associated with potentially hazardous activities and risks to DOE missions including schedule, cost, and scope uncertainties). Oversight priorities are to be based on a systematic analysis of hazards, risks, and past performance of organizations, programs, and facilities, including previous assessment results. Higher hazard or risk activities (e.g., facilities with a higher nuclear material attractiveness level) and less mature programs will be assessed more frequently and/or in more depth. The scope and results of reviews by external regulators (e.g., the Environmental Protection Agency) and organizations (e.g., the Defense Nuclear Facilities Safety Board) are important factors in determining oversight priorities but are not a substitute for effective line management oversight.

DOE Headquarters and field element line management regularly assess site assurance systems to determine the appropriate level of overlap and redundancy of DOE Headquarters and field element line management oversight. Accordingly, DOE line management organizations may increase their frequency and/or depth based on performance deficiencies or events or may decrease the frequency and/or depth of line management oversight assessments to reflect sustained effective site performance. Although external organization reviews and the effectiveness of assurance systems are considered in determining DOE line management oversight priorities and the scope and frequency of oversight activities, DOE line management must always maintain an adequate minimum baseline oversight program that enables DOE line management to understand the hazards and risks of activities.

Performance Indicators and Measures

Performance indicators and measures will be used as one mechanism to help line management identify adverse trends and promote improvements. This data is considered in a variety of management decisions, such as allocating resources, establishing goals, identifying performance trends, identifying potential problems, and applying lessons learned and good practices. Site performance criteria will focus on results and system-based metrics to drive improvements in site programs and management systems at DOE sites.

Self-Assessments of Line Management Functions

DOE Headquarters, field element and contractor line management must perform self-assessments of its activities, including its oversight activities and activities necessary to support site assurance and mission activities. Headquarters, field element, and contractor management organizations are responsible for establishing effective management assessments and line management oversight processes and to address shortcomings, identified through self-assessments, in their oversight programs.

Federal Responsibility and Accountability for Activities

DOE line management will require that contracts adequately delineate contractor responsibilities for programs, management systems, and assurance programs. Contractors are responsible for complying with the terms of their contracts and providing adequate assurances (through assurance systems) that their contracts are implemented in a safe, secure, and effective manner.

DOE line management and contractors may perform some assessments jointly to increase efficiency and promote common understanding of processes and results. However, DOE line management is responsible and accountable for understanding and accepting the hazards and risks associated with activities. To accomplish this, DOE has the right and responsibility to perform oversight at the level necessary to understand the hazards and risks, to ensure compliance with applicable requirements, to pursue excellence through continuous improvement, to ensure timely identification and correction of deficient conditions, and to verify the effectiveness of completed corrective actions.

g. Discuss the requirements imposed by DOE O 226.1 on the contractors that operate DOE nuclear facilities.

Contractor requirements

- A comprehensive and integrated contractor assurance system must be established to identify and address program and performance deficiencies, opportunities for improvement, provide the means and requirements to report deficiencies to the responsible managers and authorities, establish and effectively implement corrective and preventive actions, and share lessons learned across all aspects of operations.
- The contractor assurance system will address the criteria described in appendix A to the contractor requirements document, or other comparably effective criteria established by responsible DOE line management, for activities such as the following:

- Assessments, including self-assessments or management assessments, operational awareness or management walkthroughs, quality assurance assessments, and internal independent assessments
    - Event reporting, including reporting, analyzing, trending operational events, accidents and injuries
    - Worker feedback mechanisms
    - Issues management (including analysis of causes, identification of corrective actions, corrective action tracking, monitoring and closure, and verification of effectiveness)
    - Lessons learned
    - Performance measures

- The contractor must submit, for DOE annual review and approval, detailed contractor assurance system program descriptions to address the following aspects of operations: (1) environment, safety, and health; (2) safeguards and security; (3) emergency management; (4) cyber security; and (5) business practices. If existing processes (e.g., quality assurance programs or integrated safety management description documents) provide adequate descriptions of the contractor assurance system, or if such processes can be modified to provide adequate descriptions, submittals under these processes can be used to meet this requirement.
- The contractor assurance system must include self-evaluations of compliance with applicable laws, regulations, national standards, DOE directives, DOE-approved plans and program documents (e.g., security plans, authorization basis documents, and quality assurance program), site-specific procedures/manuals, criteria review and approach documents, contractual performance objectives, and other contractually mandated requirements.
- Contractor personnel who manage and perform assurance functions must possess experience, knowledge, skills, and abilities commensurate with their responsibilities.
- The contractor must establish and maintain appropriate qualification standards for personnel with oversight responsibilities.
- The contractor must establish and clear, unambiguous lines of authority and responsibility for personnel performing oversight.
- The contractor must provide unfettered access to information and facilities to conduct an effective oversight program, consistent with applicable laws and requirements.
- Oversight and assurance processes may identify DOE directives or site-specific requirements that conflict, are unclear, or are incomplete. Deficiencies in DOE requirements must be brought to the attention of the contracting officer and forwarded to the responsible DOE Headquarters policy organization (the Office of Primary Interest) for resolution.

h. Describe criteria review and approach documents and their use in performing oversight.

A key part of preparing the review plan is developing detailed, site-specific criteria review and approach documents (CRADs). These documents establish the initial scope of the verification and provide guidance to the verification team members. The importance of appropriately tailoring the CRADs to the management systems and operations of each site cannot be over-emphasized. The CRADs serve to focus the initial investigation by the review team. If the CRADs are too general, the review team may waste considerable time by (1) failing to focus on the pertinent issues and concerns and (2) duplicating the efforts of other members of the team. However, it should also be made clear to the reviewers that the review plan may need to be modified as the review progresses in order to accommodate new information that may have been overlooked in the initial site visit.

i. Describe the role of the Defense Nuclear Facilities Safety Board in oversight of DOE defense nuclear facilities.

The Board is an independent executive branch establishment responsible for providing advice and recommendations to the President and the Secretary of Energy (Secretary) regarding public health and safety issues at Departmental defense nuclear facilities.

References: DOE G 450.4-1B, *Integrated Safety Management System Guide for Use with Safety Management System Policies (DOE P 450.4, DOE P 450.5, and DOE P 450.6); The Functions, Responsibilities, and Authorities Manual; and the Department Of Energy Acquisition Regulation*
DOE M 140.1-1B, *Interface with the Defense Nuclear Facilities Safety Board*
DOE M 426.1-1A, *Federal Technical Capability Manual*
DOE O 226.1, *Implementation of Department of Energy Oversight Policy*
DOE P 226.1, *Department of Energy Oversight Policy*

25. Personnel shall demonstrate a familiarity level knowledge of DOE O 210.2, DOE Corporate Operating Experience Program.

a. Describe the objectives of DOE O 210.2, DOE Corporate Operating Experience Program.

The objectives of the Order are

- to institute a DOE wide program for the management of operating experience to prevent adverse operating incidents and to expand the sharing of good work practices among DOE sites;
- to provide the systematic review, identification, collection, screening, evaluation, and dissemination of operating experience from U.S. and foreign government agencies and industry, professional societies, trade associations, national academies, universities, and DOE and its contractors;
- to reinforce the core functions and guiding principles of DOE's Integrated Safety Management System (ISMS) to enhance mission safety and reliability;
- to provide mutual integration with the lessons learned requirements in other DOE directives.

b. Describe the types of information that are being collected and analyzed.

Sources of internal and external operating experience must be used to assess trends and safety issues that may have a bearing on the safety and success of DOE missions. Sources include

- DOE contractors;
- DOE programs and site offices, including the Naval Reactors Program;

- U.S. industry, professional societies, trade associations, national academies, and universities;
- other Federal agencies [e.g., the Chemical Safety and Hazard Investigation Board, National Transportation Safety Board, National Aeronautics and Space Administration, Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), etc.];
- foreign government and foreign industry experience;
- international agencies involved with energy issues [e.g., the International Energy Agency and the International Atomic Energy Agency].

c. Describe the types of operating experience reports that are developed.

Operating experience must be collected, stored, and retrieved through a central clearinghouse that allows ready access to and communication about collected information on a timely, unimpeded basis by all DOE elements. The Corporate Operating Experience Program Lead Office, who is responsible for operating the clearinghouse, must

- ensure that operating experience data are sufficiently comprehensive and of sufficient quality to meet DOE needs;
- develop, promulgate, and maintain support systems needed to implement and sustain an effective operating experience program, including
  - the computerized data systems for environment, safety and health reporting required by DOE O 231.1A, *Environment, Safety and Health Reporting,* dated 6-3-04;
  - operating experience web pages;
  - operating experience analytic tools.

References: DOE O 210.2, *Corporate Operating Experience Program*

26. Personnel shall demonstrate a familiarity level knowledge of DOE O 225.1A, Accident Investigations.

a. Describe the accident investigation process.

The Accident Investigation Board (Board) shall be responsible for conducting a thorough investigation of all individuals, organizations, management systems, and facilities having a stake in or potential impact on the accident, as well as the operation or oversight of the facility, area, or activity involved in the accident, including all levels of the organization up to and beyond the level of the appointing official.

The Board shall determine the facts of the accident by examining the accident scene, examining DOE and contractor documentation, interviewing witnesses and other personnel directly associated with the accident, and performing engineering tests and analyses as appropriate. The Board shall also examine policies, standards, and requirements that are applicable to the accident being investigated, as well as management and safety systems at Headquarters and in the field that could have contributed to or prevented the accident.

The Board shall analyze the facts and identify causal factors and judgments of need. The Board shall assure that all causal factors (including root causes) have been identified, that the conclusions are supported by the facts and analysis, and that the judgments of need are consistent with the facts and conclusions.

The Board shall evaluate the effectiveness of safety management systems (as defined by DOE P 450.4, *Safety Management System Policy*), the adequacy of policy and policy implementation, and the effectiveness of line management oversight as they relate to the accident.

Prior to completion of the investigation, the Board shall conduct an internal review of the investigation process to ensure that

- all of the pertinent facts, standards, and requirements relating to the accident have been identified, a thorough analysis of them has been conducted, and causal factors have been determined;
- judgments of need have been stated and can be supported by the facts.

The Board shall report investigation results without determining individual fault or proposing punitive measures. The report shall contain judgments of need based on objective analysis of the facts, root and contributing causes, and DOE or contractor management systems that could have prevented the accident.

The Board shall offer the facts section of the draft investigation report to the affected DOE and contractor line management to allow a review for factual accuracy prior to completion of the report.

Prior to completion of the investigation, the Board shall

- conduct a review of the report to ensure its technical accuracy, completeness, and internal consistency;
- ensure that the report includes results from an analysis of management control and safety systems that may have contributed to the accident;
- ensure that a review of the report is conducted by qualified and authorized personnel to determine that it does not contain classified or unclassified controlled nuclear information, or information protected by the Privacy Act. Documentation that these reviews have been conducted shall be retained as part of the investigation file.

The Board chairperson and Board members shall sign and date the final investigation report and, if appropriate, include a minority report section should any Board member wish to offer an opinion different from that of the Board.

The Board shall submit the investigation report to the appointing official for acceptance within the time frame established by the appointing official. Once the accident investigation report is accepted by the appointing official, the report is considered final, and the Board is released from its responsibilities.

b. Describe the roles and responsibilities of key participants in accident investigations.

Heads of Field Elements

- Determine whether adequate protection can most effectively be achieved by continuing to operate under the terms of existing contracts requiring compliance with old Orders or by modifying the contract to incorporate the requirements of revised Orders. Field elements are responsible for determining that implementation of new rule or Order requirements will provide adequate protection prior to requesting contract modifications that delete old Order requirements from contracts.
- After incorporating this Order into contracts, ensure its implementation and identify a single point of contact to act as liaison with the Office of the Deputy Assistant Secretary for Oversight on matters pertaining to the DOE Accident Investigation Program.
- Categorize the type of accident investigation to be conducted. The categorization of all Type A and Type B accident investigations shall be reported in a timely manner to the Office of the Deputy Assistant Secretary for Oversight.
- Serve as appointing officials for Type B or delegated Type A Accident Investigation Boards.
- Ensure establishment of accident investigation capability by trained contractor readiness team(s) (see Attachment 1). This includes the responsibility for providing training required to assure readiness to assist in DOE accident investigations.
- Ensure readiness teams and emergency management personnel coordinate or integrate their activities to facilitate an orderly transition of responsibilities for the accident scene.
- Provide cooperation with and assistance to DOE Accident Investigation Boards.
- Ensure that a sufficient number of DOE Accident Board Chairpersons and DOE Accident Investigators are available to implement this Order for both Type A and Type B accident investigations and, upon request, provide them to other DOE sites.
- Review draft Type A and Type B investigation reports for factual accuracy within the time frame allowed for the investigation.
- Develop lessons learned for Type B accident investigations when serving as the appointing official.
- Initiate actions to address applicable lessons learned from investigations conducted at other DOE sites.
- Ensure that corrective action plans are
  - developed to address judgments of need identified by the Board and submitted to the responsible Secretarial Officer (program office) and to the Office of the Deputy Assistant Secretary for Oversight, nominally within 30 calendar days of report acceptance by the appointing official;
  - submitted to the responsible Secretarial Officer for approval;
  - submitted to the Office of the Deputy Assistant Secretary for Oversight for review;
  - implemented and tracked to completion.
- Provide biannual (in January and July of each year) status reports of accident investigation corrective actions to the Office of the Deputy Assistant Secretary for Oversight until all corrective actions are completed.

Appointing Official

- Formally appoint DOE employees to Type A or Type B Accident Investigation Boards within three calendar days of categorization of the accident. The appointment must be in writing.
- Ensure that the Board's authority is clear in investigating all potential causes of a given accident, including individuals, organizations, and management systems up to and beyond the level of the appointing official.
- Ensure the Board is briefed on their roles and responsibilities, stressing the Board's authority and other pertinent information, within three calendar days of their appointment.
- Accept the investigation report by signing and dating a statement to this effect which is subsequently incorporated into the final report. Once accepted, the report is considered final and the Board is released from its responsibilities.
- Publish and distribute the accident investigation report within 7 calendar days of report acceptance.
- Develop lessons learned for dissemination throughout the Department within 90 calendar days of report acceptance.

Board Chairpersons

- Manage the investigation process, direct the Board members in their activities, and represent DOE in all matters regarding the accident investigation.
- Ensure that a thorough and competent investigation is completed.
- Notify the Director, Office of Enforcement and Investigation (EH-10), of any potential Price-Anderson enforcement concerns identified during the investigation.
- Notify DOE, Federal, state, or local investigative or law enforcement agencies of suspected unlawful activity identified during the accident investigation.
- Coordinate Board activities with all organizations having an interest in the accident.
- Ensure that the Board is supported by appropriate advisors and consultants who provide specialized expertise as deemed necessary.

c. Describe accident investigation data collection and data analysis techniques.

Physical evidence should be gathered and a record made of all facts from all sources, including witness statements and interview transcripts, as soon as they become available. A good method for displaying the facts is to list them on removable, adhesive-backed notes that can be placed on a wall, so they can be used to develop the events and causal factors chart.

Photographs, videotapes, and sketches should be used for recording and documenting the accident scene. The readiness team should document the accident scene initially (even though the board may wish to record the scene later as well). It is important to record the location, orientation, and subject matter for each photograph. Photographic coverage should be detailed, complete, and, if necessary, should include standard references to help establish distance, perspective, color, and date. Photographs (digitized photographs are preferred) should be taken of obstructions, equipment, parts, material, debris, spills and stains, and anything else that may contribute to or affect the accident scene.

Videotapes should cover the overall accident scene and should focus on specific locations or items of significance. A thorough videotape may relieve the board from making repeated visits to the accident scene; this may be important if the scene is difficult to access or it presents hazards of any kind. If evidence must be moved, its exact location and orientation at the scene should first be recorded in detail, perhaps using sketches with measured distances and directions from reference objects that will remain at the scene.

The original location of evidence can also be marked (using paint, tape, chalk, etc.) before it is removed. A documented chain of custody on still video camera disks and prints should be maintained. Color film pictures are preferred. These pictures should be carefully logged on an accepted form with information recording the exact time, location, direction, and other pertinent data. Photographic aids that record the date and time on the negative should be avoided, because these images may obscure important details in the photo or video. Reference aids such as rulers, grids, and color charts should be included in the photographs when there is any chance for distorted interpretation; size, color, and exact location are critical. Videotapes are of particular value at accident scenes where progression of events is critical, such as fires. Other specialized photographic techniques may be desirable in certain circumstances. These special techniques are used to identify foliage changes, internal conditions, and other effects not visible to normal sight. They include aerial, micrographic, ultraviolet, infrared, false color, motion pictures, stereo, x-rays, and thermal scanners.

Physical evidence should be gathered and assigned to categories, and a record should be made of all facts from all sources, including the witness statements and interview transcripts as soon as they become available. Care should be taken in the event pathogenic contamination of physical evidence occurs (e.g., in the case of blood). Such material may require autoclaving or other sterilization. Work practice controls, as defined by 29 CFR 1910.1030, should be used. Actions taken to mitigate bloodborne pathogen hazards resulting from the accident should be documented. Potential exposures to team members should be investigated and referred to the appropriate medical personnel for immediate treatment. 29 CFR 1910.1030 details controls that should be followed for exposure to blood or other potentially infectious materials. In addition, a record must be established and maintained for each investigation team member who has an occupational exposure (see 29 CFR 1910.20 and 1910.30).

Physical evidence is fragile: physical objects can be removed, broken, lost, misplaced, cleaned up, destroyed, distorted, or overlooked. When physical evidence is identified, it is collected and secured or the area in which it is located is secured to preserve integrity of the evidence. Materials can be bottled, bagged, or boxed, and their locations recorded or photographed. The accident scene can be roped or taped off, doors locked, and guards posted, or it can be preserved by other means.

Interviews should be conducted to collect evidence of the accident. Human evidence can be extremely delicate. Eyewitnesses can forget, overlook, or fail to recall evidence of critical value to the investigation. Individuals naturally begin to rationalize the circumstances of traumatic accidents after the event. Therefore, to preserve accuracy, the preferred approach is to obtain and record initial eyewitness statements before the participants and witnesses leave the accident site. This step should be taken as part of the initial response efforts.

After the board arrives, a witness interviewing schedule should be established, and interviewing should begin as soon as practical. A neutral location free from distractions (phones, noise, etc.) should be reserved for these interviews. Each board member is responsible for assuring that the interviews are effective and productive. Court reporters should be used to document key interviews to ensure accuracy and expeditious availability of transcripts to the board. Recording should commence at the opening statement. In some cases, those being interviewed may request the presence of an attorney or union representative during the interview. Unless directed to do otherwise by DOE legal counsel, this request should be honored. The transcript should then be reviewed for accuracy by the board and the witness, and discrepancies should be resolved. The transcript should be read by all board members and placed in the investigation files.

d. Describe the development of conclusions and judgments of need.

The judgments of need are the board's decisions regarding the managerial controls and safety measures necessary to prevent or minimize the probability or severity of a recurrence. Judgments of need should also provide the basis for subsequent corrective actions. DOE O 225.1A requires that each accident investigation report contain judgments of need for corrective actions based on an objective analysis of the facts and the causal factors, including DOE or contractor management systems, that could have prevented the accident. Judgments of need should not include accident investigation process issues (e.g., evidence control, preservation of the accident scene, readiness, etc.) unless they have a direct impact on the accident. These concerns should be noted in a separate memorandum to the appointing official, with a copy to site management and the Assistant Secretary for Environment, Safety and Health.

Judgments of need should be constructed so they clearly identify the organization that is to implement corrective actions to prevent recurrence of the accident. The board should avoid generic statements and focus on processes and systems, not individuals. Judgments of need should focus on causal factors. Being specific and concise is essential; vague, generalized, broad-brush, sweeping solutions introduced by "should" statements ought to be avoided. Sentences listing judgments of need may start, *"A need exists . . ."* or, *"There is a need to . . ."* As an example, a judgment of need might be worded, *"There is a need for XYZ corporation to ensure that an adequate hazards analysis is performed prior to changes in work tasks that affect the safety and health of personnel."* A judgment of need does not tell management how to do something; instead, it simply identifies the need. Corrective action plans are prepared to address the judgments of need. The resulting corrective actions are the responsibility of line management. If the board finds the need to make specific recommendations, they should be listed in a separate communication and not in the body of the report or transmittal letter to the appointing official.

References: DOE G 225.1A-1, *Implementation Guide for Use with DOE Order 225.1A, Accident Investigations*
DOE O 225.1A, *Accident Investigations*

27. Personnel shall demonstrate a familiarity level knowledge of DOE O 410.1, Central Technical Authority Responsibility Regarding Nuclear Safety Requirements.

a. State the purpose of DOE O 410.1, Central Technical Authority Responsibility Regarding Nuclear Safety Requirements.

The purpose of the Order is

- to establish Central Technical Authority (CTA) and Chief of Nuclear Safety/Chief of Defense Nuclear Safety responsibilities and requirements directed by the Secretary of Energy in the development and issuance of DOE regulations and directives, including standards that affect nuclear safety;
- to identify CTA authorities and actions for specific regulations and directives;
- to establish related responsibilities and requirements for other Departmental elements;
- to establish responsibilities and requirements for addressing nuclear safety regulations and directives in contracts.

b. Define the following terms:

- **Exception**
- **Exemption**

Exception

The situation that exists when Work Smart Standards, Standards and Requirements Identification Documents, approved Safety Management System or similar processes are used to modify an applicable Contractor Requirements Document (CRD) provision for inclusion in a contract, and a knowledgeable person would reasonably conclude that the apparent meaning of the CRD provision has not been met by its contractual treatment. Exceptions are taken to provide relief from what would be a requirement were a CRD provision included in the contract as it is written in the directive where it appears.

Exemption

Exemptions may apply to Federal personnel and/or contractors. For Federal personnel, an exemption is formal and final relief from the need to comply with applicable requirements of DOE regulations and directives. For contractors, an exemption is a formal and final release from a provision in a DOE Order, Notice, or Manual that has been included in their contract; or from one or more requirements in a regulation. Processes for obtaining approval for exemptions to 10 CFR 830 are found in 10 CFR 820; related guidance is provided in DOE STD 1083. Processes for obtaining approval to exemptions to DOE Orders, Notices and Manuals are either included in the Directive or are found in DOE M 251.1-1B.

c. List all the documents and directives that require Central Technical Authorities/Chief of Nuclear Safety/Chief of Defense Nuclear Safety concurrence before they are issued.

CTA concurrence is required on directives included pursuant to 48 CFR 970.5204-2 paragraphs (b) and (c) in all new prime management and operating, management and integration, design, and construction contracts for DOE nuclear facilities.

Note: In the following, “CTA” includes all CTAs having responsibilities for nuclear facilities that are covered by a particular contract or that would be affected by granting an exemption or exception:

- CTA concurrence is required prior to approval of exemptions to 10 CFR 830 and prior to approval of exemptions or exceptions to the directives listed in Attachment 1 of DOE O 410.1.
- CTA concurrence is required prior to approval of a methodology other than that given in table 2-1, appendix A of subpart B to 10 CFR 830 for preparation of a documented safety analysis for a hazard category 1, 2 or 3 nuclear facility.
- CTA concurrence is required on the directives included pursuant to 48 CFR 970.5204-2 paragraph (b) and paragraph (c) in requests for proposals (RFP) for new prime contracts for DOE nuclear facilities prior to the release of the RFP. CTA concurrence is required prior to contract award if changes are made to the included directives after initial RFP is released.
- CTA concurrence is required on directives included pursuant to 48 CFR 970.5204-2 paragraph (b) and paragraph (c) prior to approving revisions to existing prime contracts when both of the following conditions exist
  - the revisions involve construction, major modification, or initiation of program work;
  - any of the Contractor Requirements Document (CRD) provisions of directives listed in Attachment 1 that are applicable to the construction, major modification or new program work were not previously included in the contract.
- Implementation of Work Smart Standards, Standards and Requirements Identification Documents, or approved Safety Management System processes used to tailor the requirements included in new or revised contracts pursuant to 48 CFR 970.5204-2 paragraph (c) must be consistent with the following requirements:
  - Directives listed in attachment 1 of DOE O 410.1, and subsequent revisions, must be evaluated for applicability within 12 months of issuance or within the time period identified in the directive, whichever is shorter;
  - Methodologies listed in table 2-1, appendix A of subpart B to 10 CFR 830 must be implemented as written when used for the development of DSAs for hazard category 1, 2, or 3 nuclear facilities, unless DOE approves the use of an alternative methodology;
  - As directives listed in attachment 1 are revised, or new directives are added to attachment 1, an integrated listing (organized by regulation or directive number as appropriate) must be developed and maintained to indicate which provisions of the new or revised CRDs have been implemented, omitted, and implemented with exceptions or in a modified form in prime contracts. Treatment of directives already in prime contracts as of the date of this order is not included in this requirement, but the treatment of future revisions to those directives is subject to this requirement;
  - As directives listed in attachment 1 are revised, or new directives are added to attachment 1, justifications must be documented and maintained for the life of the prime contract that explain the contractual treatment of new or revised CRD provisions not included in the contract as written in the CRD. Treatment of directives already in contracts as of the date of this order is not included in this

requirement, but the treatment of future revisions to those directives is subject to this requirement.

- CTA concurrence is required prior to approval of a revision to or cancellation of 10 CFR 830 or the directives and regulations listed in attachment 2 of DOE O 410.1.
- CTAs must be notified prior to Department-wide review and comment of new directives. Where the CTA concludes that a new regulation or directive does not affect nuclear safety, coordination with the CTA will not be required.

d. State the responsibilities of the Central Technical Authorities.

Note: In the following subsections, when more than one CTA is responsible for nuclear facilities to which a directive is applicable, or that are covered by a particular contract or that would be affected by granting an exemption or exception, all responsible CTAs must concur on the associated action.

The responsibilities of the CTA are the following:

- Concur with exemptions to 10 CFR 830 and exemptions or exceptions to the directives listed in attachment 1 of DOE O 410.1—for directives, within the time limits both exemptions and exceptions; for exemptions to 10 CFR 830, no later than 30 days before the time limit for approval elapses;
- Concur with revision or cancellation of directives and regulations listed in attachment 2 of DOE O 410.1;
- Concur with new regulations and directives that that the CTA identifies as affecting nuclear safety;
- For structures, activities and operations for which they are responsible
  - Concur with the directives included in RFPs and in new prime contracts for nuclear facilities;
  - Concur with the directives included in prime contract revisions that allow for construction, major modification or new program work when both of the following conditions apply: 1) any of the CRD provisions of directives listed in attachment 1 are applicable to the construction, major modification or new program work, and 2) the applicable CRD provisions are not already included in the prime contract.
- Identify documents that affect nuclear safety by approving changes to attachments 1 and 2 for existing documents, and by notifying the Office of Primary Interest or the preparing activity for new documents as early in the coordination process as possible, preferably during precoordination, that CTA concurrence will be required;
- Concur with the use of any methodology other than that given in table 2-1, appendix A of subpart B to 10 CFR 830 to prepare a documented safety analysis for a hazard category 1, 2 or 3 nuclear facility within 150 calendar days of receipt of the request for concurrence.

e. State the responsibilities of the Chief of Nuclear Safety and Chief of Defense Nuclear Safety.

The responsibilities of the Chief of Nuclear Safety and the Chief of Defense Nuclear Safety are as follows:

- Develops and maintains a baseline list of known exemptions to 10 CFR 830 and exemptions or exceptions taken in prime contracts for nuclear facilities to directives identified in attachment 1
- Evaluates requests for exemptions to 10 CFR 830 and for exceptions or exemptions to directives identified in attachment 1 and for each request, provides the CTA a written summary of the evaluation along with a recommendation regarding concurrence
- Evaluates requests for revision or cancellation of regulations and directives listed in attachment 2; and, for each request, provides the CTA a written summary of the evaluation along with a recommendation regarding concurrence
- Evaluates new and revised regulations and other documents for inclusion in attachments 1 and 2 and provides the CTA a written summary of the evaluation and justification for each document recommended for inclusion as early in the coordination process as possible, preferably during precoordination
- Evaluates RFPs and new or revised nuclear facility contracts for adequacy of the directives included and provides the CTA written summaries of the evaluations along with recommendations regarding concurrence
- Maintains a list of approved deviations from the double contingency principle (DOE O 420.1B)
- Evaluates the use of any methodology other than that given in table 2-1, appendix A of subpart B to 10 CFR 830 to prepare a documented safety analysis for a hazard category 1, 2 or 3 nuclear facility and for each request, provides the CTA a written summary of the evaluation along with a recommendation regarding concurrence.

References: DOE O 410.1, *Central Technical Authority Responsibilities Regarding Nuclear Safety Requirements*

28. Personnel shall demonstrate a familiarity level knowledge of DOE security programs, including DOE O 470.4, Safeguards and Security Program, and its implementing manuals.

a. Discuss information security programs, including control of classified materials as described in DOE M 470.4-4, Information Security.

To ensure the protection and control of classified matter, a classified matter protection and control (CMPC) program must be implemented to cover each Program Office, site, and facility. The CMPC program, in addition to ensuring the compliance with the requirements of DOE M 470.4-4, must also include the following activities:

- Establishment of a point of contact with overall CMPC responsibilities for each site, facility, and program office whose name and contact information shall be provided to the Office of Safeguards and Security Policy
- CMPC point of contact participation in the development of local implementation training and/or briefings tailored to the job duties of the individual employees
- Development and execution of a comprehensive CMPC awareness program that includes regular briefings to ensure personnel are aware of their responsibilities in support of the CMPC program. These briefings provide local implementation of National and Departmental requirements and may be integrated into or provided in conjunction with required security briefings (e.g., new hires' initial briefings, comprehensive or annual refresher briefings)

- Participation in self-assessments to ensure the National, Departmental, and local requirements to protect and control classified information are being followed in all areas and employees are aware of their responsibilities
- Provision of information concerning policy deviations (e.g., variances, waivers, and exceptions) involving the CMPC program to the Office of Safeguards and Security Policy, and to the Associate Administrator for Defense Nuclear Security when involving National Nuclear Security Administration (NNSA) facilities, in a timely fashion, to include implementation and expiration of such actions
- Promulgation of new CMPC requirements to all affected employees in a timely fashion
- Interaction and coordination with Office of Safeguards and Security Policy on CMPC National and Departmental requirements interpretation and local implementation activities. Interaction and coordination between NNSA facilities and the Office of Safeguards and Security Policy is through the Associate Administrator for Defense Nuclear Security

Classified matter protection programs must be tailored to address specific site characteristics and requirements, current technology, ongoing programs, and operational needs. These programs must also be customized to achieve protection levels that adequately and cost-effectively reduce risk.

b. Discuss physical protection programs, including security areas, intrusion detection, and access controls, as described in DOE M 470.4-2, Physical Protection.

The priority of protection measures must be designed to prevent malevolent acts such as theft, diversion, and radiological sabotage and to respond to adverse conditions such as emergencies caused by acts of nature. Special Nuclear Material (SNM) must be protected at the higher level when credible roll-up (e.g., Category II quantities to a Category I quantity of SNM) can occur unless the facility has conducted a vulnerability assessment that determined that the failure or defeat of protection measures would not decrease system effectiveness.

A facility must not possess, receive, process, transport, or store nuclear weapons or SNM until that facility has been cleared commensurate with DOE M 470.4-1, Safeguards and Security Program Planning and Management.

An integrated system of positive measures must be developed and implemented to protect Category I and II quantities of SNM and nuclear weapons. Protection measures must address physical protection strategies of denial and containment as well as recapture, recovery, and/or pursuit.

Physical protection for each category of SNM must consider the following factors: quantities, chemical forms, and isotopic composition purities; ease of separation, accessibility, concealment, portability; radioactivity; and self-protecting features.

The protection of nuclear material production, reactors, and fuel must be commensurate with the category of SNM.

SNM, parts, or explosives that are classified must receive the physical protection required by the highest level of classification or category of SNM, whichever is the more stringent.

Specific physical protection measures and protective force response capabilities must be described in a Site Safeguards and Security Plan or Site Security Plan.

The protection afforded SNM must be graded, according to the nuclear material safeguards category and attractiveness level, and reflect the specific nature of the nuclear weapons or SNM at each site.

Access

Access controls must be in place to ensure that only appropriately cleared and authorized personnel are permitted unescorted access to SNM and nuclear weapons. Access authorizations must be granted commensurate with DOE M 470.4-5, *Personnel Security.*

Intrusion Detection Systems

Nuclear weapons and Category I and II quantities of SNM must be protected by an integrated physical protection system using protective force, barriers, and intrusion detection systems that annunciate at a central alarm station.

c. Describe how the design basis threat is used in safeguards and security planning in accordance with DOE M 470.4-1, Safeguards and Security Program Planning and Management.

DOE O 470.3A, *Design Basis Threat (DBT) Policy* must be used with local threat guidance during the conduct of vulnerability assessments for protection and control program planning. The DBT must be the baseline threat definition but local threat guidance may be used to increase the level of threat to be analyzed.

d. Discuss the basic requirements of material control and accountability per DOE M 470.4-6, Nuclear Material Control and Accountability.

DOE line management and site/facility operators must consider material control and accountability (MC&A) requirements, systems, technologies, and activities when planning, designing, constructing, and operating new or renovated DOE facilities. The site/facility operator must use techniques and equipment that maximize material loss detection sensitivity, increase the quality of accountability measurements, minimize material holdup, and reduce the magnitude of inventory differences and associated control limits consistent with the consequences of the loss of the material.

An MC&A program must be established and maintained for all materials identified in Table I-1, Nuclear Materials of DOE M 470.4-6. The level of control and accountability must be graded based on the consequence of their loss.

Special nuclear material must not be received, processed, or stored at a facility until a facility approval has been granted.

MC&A programs must be designed to deter and detect theft and diversion of nuclear material by both outside and inside adversaries.

A performance testing program to verify MC&A procedures and practices and to demonstrate that material controls are effective must be established.

MC&A programs must address both the theft and diversion of SNM and the unauthorized control of a weapon, test device, or materials that can be used to make an improvised nuclear device.

DOE M 470.4-6 requires that various documents, actions, and activities be approved by the DOE cognizant security authority:

- For each site/facility subject to the requirements of this Manual, a specific DOE cognizant security authority must be designated as the approving authority for these documents, actions and plans.
- Approval authorities may be delegated in writing to other DOE cognizant security authorities.
- The same official can be designated as the approving authority for more than one site/facility.

The site/facility operator must designate a management official to be responsible for the MC&A program. This official must be organizationally independent from responsibility for nuclear material utilization programs, including nuclear material production, storage, processing, research, and disposition. This official must have responsibility for and the authority to ensure the safeguards of accountable nuclear material, along with operations personnel.

A reporting identification symbol (RIS) must be established for all nuclear materials on inventory. Requirements for establishing and maintaining a RIS are detailed in Section B of this Manual.

A nuclear materials representative (NMR) must be designated for each site/facility with a RIS. The NMR is to be responsible for nuclear materials reporting and data submission to the Nuclear Materials Management and Safeguards Systems (NMMSS) (see Section B of this Manual for NMMSS reporting requirements).

Authorities and responsibilities for MC&A functions (e.g., accounting system, measurements, measurement control, inventories, audit, material access controls, and surveillance) must be defined and documentation must be maintained.

MC&A program implementation must facilitate, to the extent practical, the cost-effective integration of the operational mission of the program while protecting the environment, health and safety of employees, and the public.

Personnel performing MC&A functions must be trained and qualified to perform their duties and responsibilities. (See DOE M 470.4-1, *Safeguards and Security Program Planning and Management*, for additional information on safeguards and security training programs.) A site-specific training program must be established, implemented and maintained. Personnel must be knowledgeable of the requirements and procedures related to their functions.

An MC&A plan providing the safeguards authorization basis must be developed and maintained for each facility possessing nuclear materials. The MC&A plan must be approved by the DOE cognizant security authority.

The MC&A plan must specify how nuclear material inventory holdings will be accounted for and controlled. The MC&A plan must include, at a minimum

- the elements of the MC&A program that are designed to deter and detect loss, theft, and diversion of nuclear materials and the unauthorized control of a weapon, test device, or materials that can be used to make an improvised nuclear device;
- measures to ensure that nuclear materials are in their authorized locations and being used for their intended purposes;
- a description of the local implementation of this Manual, which must document how the MC&A program meets the requirements of this Manual;
- facility-specific requirements approved by the DOE cognizant security authority including, but not limited to, agreements between Government and contractor organizations, access control and material surveillance testing measures, and the scope and extent of the performance testing program;
- MC&A plan review frequency and change control mechanisms.

e. Discuss the responsibilities of field elements and contractor employees in identifying classified information as defined in DOE M 470.4-4, Information Security.

Heads of Field Elements

- Ensure that the necessary staff are designated to fulfill the requirements contained in DOE M 475.1-1A, *Identifying Classified Information*
- Ensure that information, documents, and material are reviewed and processed in accordance with the requirements in DOE M 475.1-1A
- Ensure that Headquarters Classification Representatives, Classification Officers, and other personnel with classification responsibilities participate in the early planning stages of any new program that may generate classified information, documents, or material
- Ensure that the management of classified information is included as a critical element or item to be evaluated in the performance standards of Headquarters Classification Representative, Classification Officers, Original Classifiers, and any other individuals whose duties include significant involvement in generating classified information, documents, or material
- Identify/appoint an individual to be responsible for notifying the contracting officer of each procurement falling within the scope of DOE M 475.1-1A. If such an individual is not identified or appointed, the person originating the procurement request assumes this responsibility

Field Elements Classifiers

- Serve as the points of contact with the Office of Nuclear and National Security Information for their field elements
- Administer the field element classification and declassification programs
- Ensure that a classification review is performed prior to the dissemination of each document that may be classified and that is prepared by a field element employee

Contractors

The Contractor Requirements Document (CRD) establishes the requirements for DOE contractors. Contractors must comply with the requirements listed in the CRD to the extent set forth in their contracts.

Regardless of the performer of the work, contractors with the CRD incorporated into their contracts are responsible for compliance with the requirements of the CRD. Affected contractors are also responsible for flowing down the requirements of the CRD to subcontracts at any tier to the extent necessary to ensure the contractors' compliance with the requirements. In so doing, contractors must not unnecessarily or imprudently flow down requirements to subcontractors. That is, contractors will ensure that they and their subcontractors comply with the requirements of the CRD and incur only those costs that would be incurred by a prudent person in the conduct of competitive business. A violation of the provisions of the CRD relating to the safeguarding or security of restricted data or other classified information may result in a civil penalty pursuant to subsection a. of section 234B of the Atomic Energy Act of 1954 (42 U.S.C. 228b.). The procedures for the assessment of civil penalties are set forth in 10 CFR 824, Procedural Rules for the Assessment of Civil Penalties for Classified Information Security Violations.

References: DOE M 470.4-1 *Safeguards and Security Program Planning and Management*
DOE M 470.4-2, *Physical Protection*
DOE M 470.4-4, *Information Security*
DOE M 470.4-6, *Nuclear Material Control and Accountability*
DOE M 475.1-1A, *Identifying Classified Information*

Appendix A – Example MSDS

XEROX **Material Safety Data Sheet**

MSDS No:	A-0057B
Date:	9/22/86
Revision:	11/13/00

Manufacturer: Xerox Corporation
Rochester, NY 14644

Telephone # (s): *Safety Information: (800) 828-6571*
Health Emergency: (716) 422-2177
Transportation Emergency (Chemtrec):(800) 424 - 9300

Section I - Product Identification

Trade Names/Synonyms: 1065/4235/5046/5047/5065/5335/5365/ 5365 SE/Document Centre System 35/ Class III / Class IV Black Dry Ink

Part No.: WH: 6R135, 6R229, 6R271, 6R311*, 6R452, 6R894, 106R2
XCI: 6R517, 6R518*, 6R523*
XL: 6R90098, 6R90147, 502S62479
NVY: CL3P6R459, CL4P6R452, CL336R459, CL466R452, CL366R459, CL436R452
*Cancelled

Chemical Name: None

WHMIS Status: This is not a WHMIS controlled product.

Ingredients (% by wt.)	**CAS No.**
Styrene/butadiene copolymer (75-80%)	9003-55-8
Iron oxide (15-20%)	1309-37-1
Carbon black (<5%)	1333-86-4
Quaternary ammonium salt (<2%)	3843-16-1

Section II - Emergency and First Aid

Primary Route of Entry:
Inhalation
Eyes:
Flush with water.
Skin:
Wash with soap and water.
Inhalation:
Remove from exposure.
Ingestion:
Dilute stomach contents with several glasses of water.

Symptoms of Overexposure:
Minimal respiratory tract irritation may occur as with exposure to large amounts of any non-toxic dust.

Medical Conditions Generally Aggravated by Exposure:
None when used as described by product literature.

Additional Information:
None.

Section III - Toxicology and Health Information

This material has been evaluated by Xerox Corporation. The toxicity data noted below is based on test results of similar xerographic materials.

Oral LD_{50}:	>10 g/kg (rats) practically non-toxic.
Dermal LD_{50}:	>2 g/kg (rabbits) practically non-toxic.
Inhalation LC_{50}:	>5 mg/l (rats, 4 hr exposure)practically non-toxic.
	>20 mg/l (calculated 1 hr exposure) non-poisonous, DOT.
Eye Irritation:	Not an irritant.
Skin Sensitization:	Not a sensitizer.
Skin Irritation:	Not an irritant.
Human Patch:	Non-irritating, non-sensitizing.
Mutagenicity:	No mutagenicity detected in Ames, Micronucleus, CHO/HGPRT, and Yeast Mitotic Recombination Assays.
Carcinogens:	None present
Aquatic LC_{50}:	>1000 mg/l (fathead minnows) non-toxic.

TLV:	10 mg/m^3 (total dust)
PEL:	15 mg/m^3 (total dust)
	5 mg/m^3 (respirable dust)
STEL:	N.E.
Ceiling:	N.E.
XEL[1]:	2.5 mg/m^3 (total dust)
	0.4 mg/m^3 (respirable dust)

Additional Information: The results obtained from a Xerox sponsored Chronic Toner Inhalation Study, demonstrated no lung change in rats for the lowest (1mg/m^3) exposure level (i.e. the level most relevant to potential human exposure). A very slight degree of fibrosis was noted in 25% of the animals at the middle (4mg/m^3) exposure level, while a slight degree of fibrosis was noted in all the animals at the highest (16 mg/m^3) exposure level. These findings are attributed to "lung overloading", a generic response to excessive amounts of any dust retained in the lungs for a prolonged period. This study was conducted using a special test toner to comply with EPA testing protocol. The test toner was ten times more respirable than commercially available Xerox toner, and would not be functionally suitable for Xerox equipment.

[1]XEL-Xerox Exposure Limit
N.A. - Not Applicable N.E. -None Established N.D. -Not Determined **600E58260**

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Section IV - Physical Data

Appearance/Odor:	Black powder / faint odor	**Softening Range:**	$85^{o}C$ to $100^{o}C$
Boiling Point:	N.A.	**Melting Point:**	N.A.
Solubility in Water:	Negligible	**Specific Gravity (H_2O=1):**	1
Evaporation Rate:	N.A.	**Vapor Pressure (mm Hg):**	N.A.
Vapor Density (Air=1):	N.A.	**pH:**	N.A.
Volatile:	N.A. % (Wt.) N.A. % (Vol.)		

Section V - Fire and Explosion Data

Flash Point (Method Used):	N.A.
Flammable Limits:	LEL: N.A., UEL: N.A.
NFPA 704:	Health - 0, Fire - 3, Reactivity - 0
Extinguishing Media:	Water, dry chemical, carbon dioxide or foam.
Special Fire Fighting Procedures:	Avoid inhalation of smoke. Wear protective clothing and self-contained breathing apparatus.
Fire and Explosion Hazards:	Toner is a combustible powder. Like most organic materials in powder form, it can form explosive mixtures when dispersed in air.

Section VI -Reactivity Data

Stability:	Stable
Hazardous Polymerization:	Will Not Occur
Hazardous Decomposition Products:	Products of combustion may be toxic. Avoid breathing smoke.
Incompatibility (Materials to Avoid):	None known

Section VII - Special Protection Information

Respiratory Protection:	None required when used as intended in Xerox equipment.
Eye Protection:	None required when used as intended in Xerox equipment.
Protective Gloves:	None required when used as intended in Xerox equipment.
Other:	For use other than normal customer - operating procedures (such as in bulk toner processing facilities), goggles and respirators may be required. For more information, contact Xerox.

Section VIII - Special Precautions

Handling and Storage:	None
Conditions to Avoid:	Avoid prolonged inhalation of excessive dust.

Section IX- Spill, Leak, and Disposal Procedures

For Spills or Leakage:	Sweep up or vacuum spilled toner and carefully transfer into sealable waste container. Sweep slowly to minimize generation of dust during clean-up. If a vacuum is used, the motor must be rated as dust tight. A conductive hose bonded to the machine should be used to reduce static buildup (See Section V). Residue can be removed with soap and cold water. Garments may be washed or dry cleaned, after removal of loose toner.
Waste Disposal Method:	This material is not a hazardous waste according to Federal Regulation 40 CFR 261 when disposed. State and Local requirements however, may be more restrictive. Consult with the appropriate State and Local waste disposal authorities for additional information. Incinerate only in a closed container.

Section X - Transportation Information

DOT Proper Shipping Name:	N.A. (Not Regulated)	**ID Number:**	N.A.
Hazard Classification:	N.A.	**Packing Group:**	N.A.

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